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E71 Chassis Dynamics Workbook

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Chassis Dynamics

Model: E71

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Identify the new components utilized in the dynamic driving system for the E71.
- Explain the purpose, function, and location of all the dynamic driving system control units.
- Explain the operation of the QMVH read differential.
- Explain the benefits to utilizing the QMVH read differential.
- Identify service concerns for the new QMVH rear differential.

Introduction

In the E70, the BMW Group introduced a new generation of dynamic driving systems that have now been comprehensively developed and enhanced in the X6 (E71). The regulating strategy of the individual systems, consistently subdivided into longitudinal, lateral and vertical dynamics, forms the basis for the wide variety of driving dynamics functions.

In the X6, the BMW Group has developed a complementary drive and dynamic driving system that enables a distinct increase in agility, stability and traction, as well as an increase in safety, without compromising dynamics or efficiency.

The complete package in the X6 includes the dynamic driving systems:

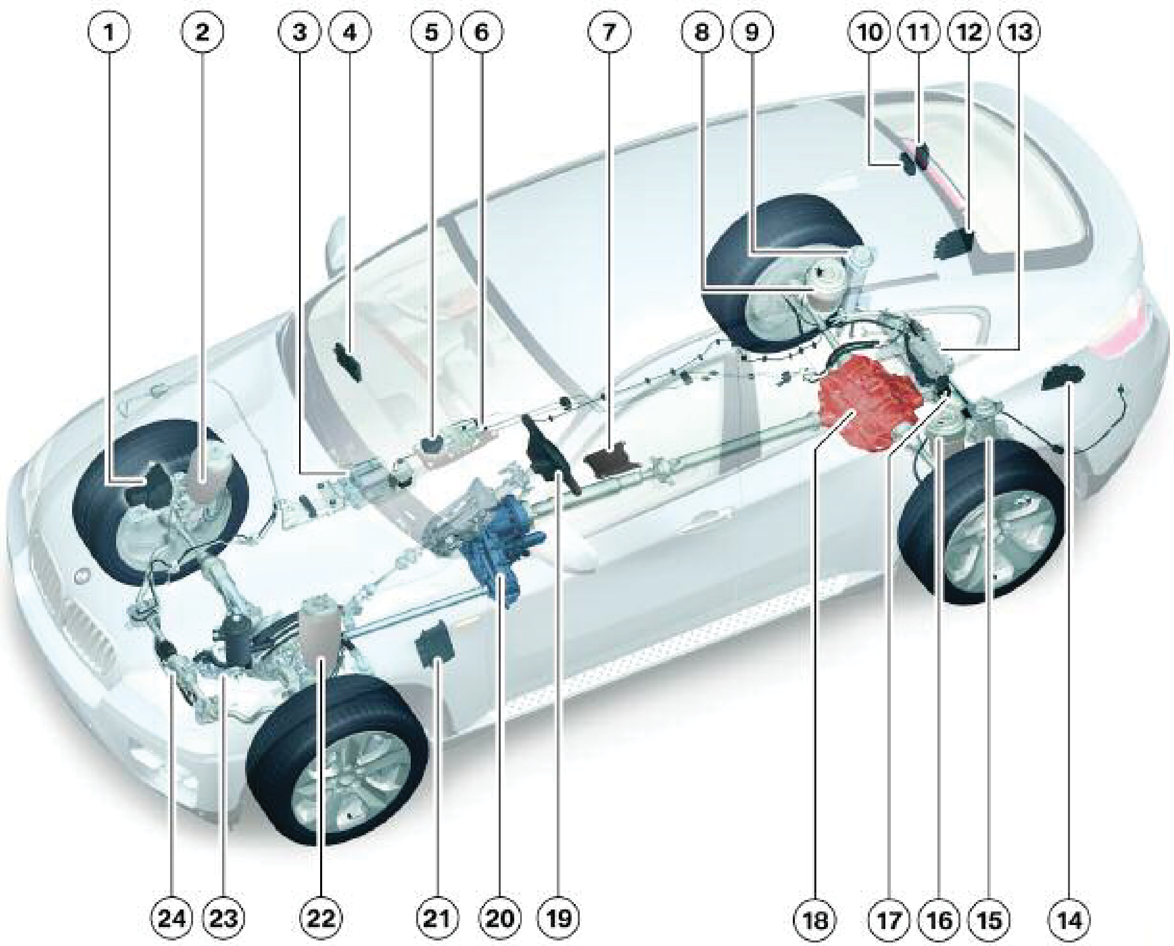
- Dynamic Drive
- Vertical Dynamic Control
- Adaptive Drive
- Electronic Height Control
- Dynamic Stability Control
- Active Steering
- xDrive
- Dynamic Performance Control

All these functions enable the highest degree of dynamic driving performance through intelligent interaction between the systems. The slogan "The Ultimate Driving Machine" is more than just an integrated policy behind the development of each BMW vehicle.

In the E71, Dynamic Performance Control forms an integral part of the standard equipment and complements xDrive and Dynamic Stability Control, serving as an additional module to increase active safety and enhance the brilliant driving dynamics. As an option, the E71 customer can also order BMW innovations in the field of dynamic driving systems, e.g. Active Steering. When combined and interlinked in the E71, these individual modules create superior driving dynamics for more intense and safer enjoyment of the Ultimate Driving Machine.

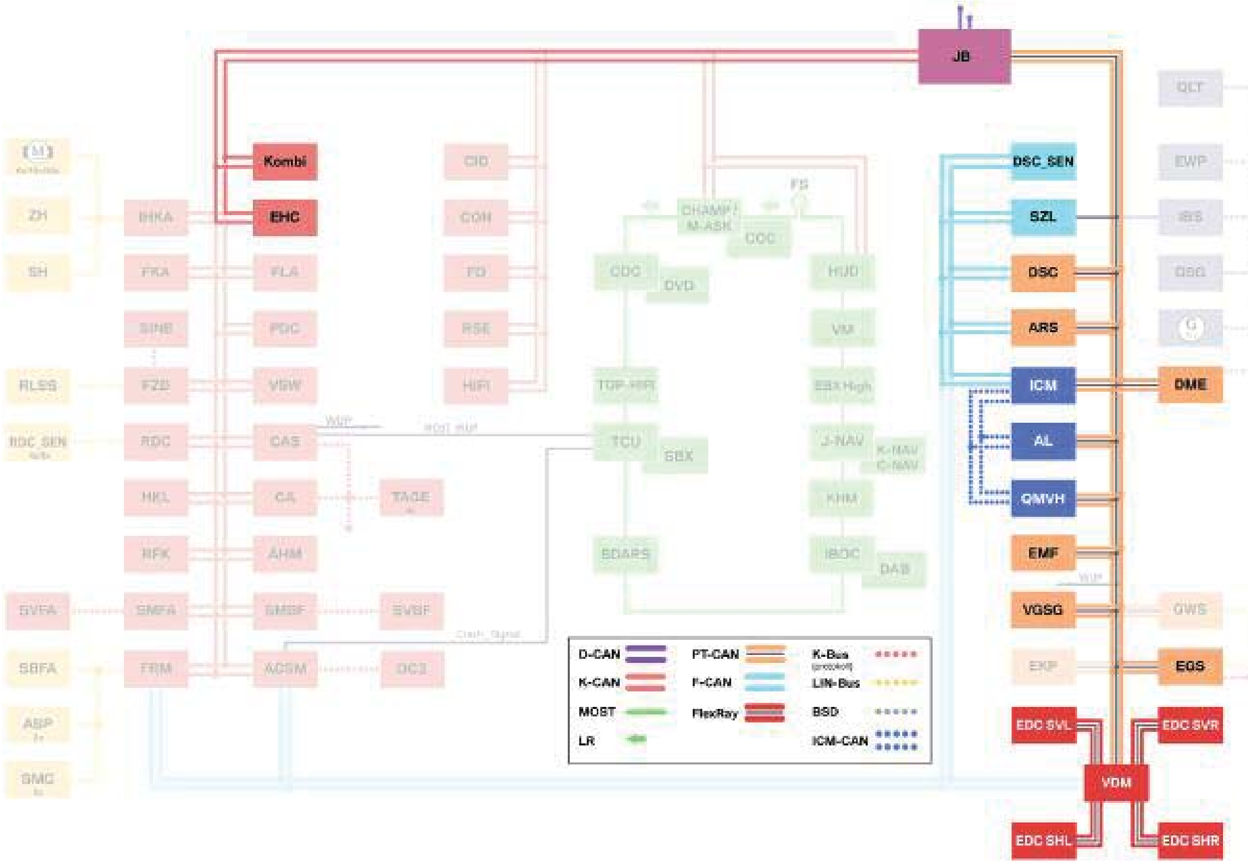
System Overview

Chassis Dynamics Components in the Vehicle



Index	Explanation
1	Dynamic stability control
2	EDC satellite, front right
3	EHC air supply unit
4	ARS control unit
5	DSC sensor
6	ARS valve block
7	ICM control unit
8	Air spring, rear right
9	EDC satellite, rear right
10	EHC control unit
11	VDM control unit
12	QMVH control unit
13	Electromechanical parking brake
14	Transfer box control unit
15	EDC satellite, rear left
16	Air spring, rear left
17	ARS hydraulic motor, rear axle
18	Rear differential with superimposing gear units [QMVH]
19	SZL with steering angle sensor
20	Transfer case
21	AL control unit
22	EDC satellite, front left
23	Power steering pump
24	ARS hydraulic motor, front axle

Bus System Overview

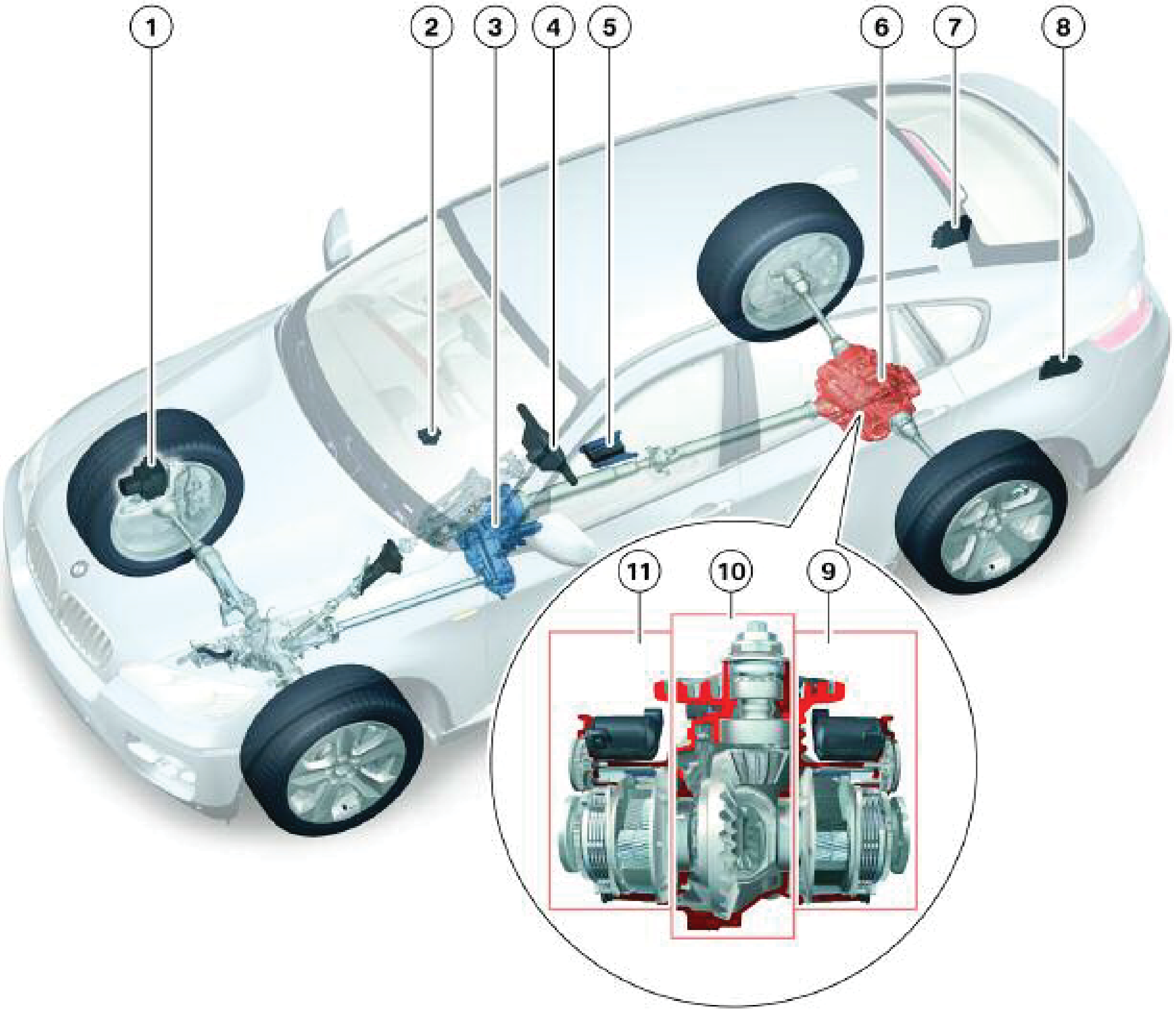


The diagram shows the control units and bus systems that are related for the dynamic driving systems.

One of the differences between the E71 and the E70 is that a new control unit known as Integrated Chassis Management (ICM) has been introduced. This ICM coordinates longitudinal and lateral dynamic control functions, which include the familiar Active Steering and the new Function Dynamic Performance Control [with QMVH]. The ICM-CAN has been introduced as a new bus system especially for the ICM system network. It connects the ICM, AL and QMVH control units.

Index	Explanation
AL	Active Steering
ARS	Active anti-roll bar
DME	Digital Engine Electronics
DSC	Dynamic stability control
DSC_SEN	DSC sensor
EDC SHL	EDC satellite, rear left
EDC SHR	EDC satellite, rear right
EDC SVL	EDC satellite, front left
EDC SVR	EDC satellite, front right
EGS	Electronic transmission control unit
EHC	Electronic Height Control
EMF	Electromechanical parking brake
ICM	Integrated Chassis Management
JB	Junction box
KOMBI	Instrument cluster
QMVH	Lateral torque distribution on the rear axle
SZL	SZL with steering angle sensor
VDM	Vertical Dynamics Management
VGSG	Transfer box control unit
ICM-CAN	Integrated Chassis Management

System Overview - Dynamic Performance Control



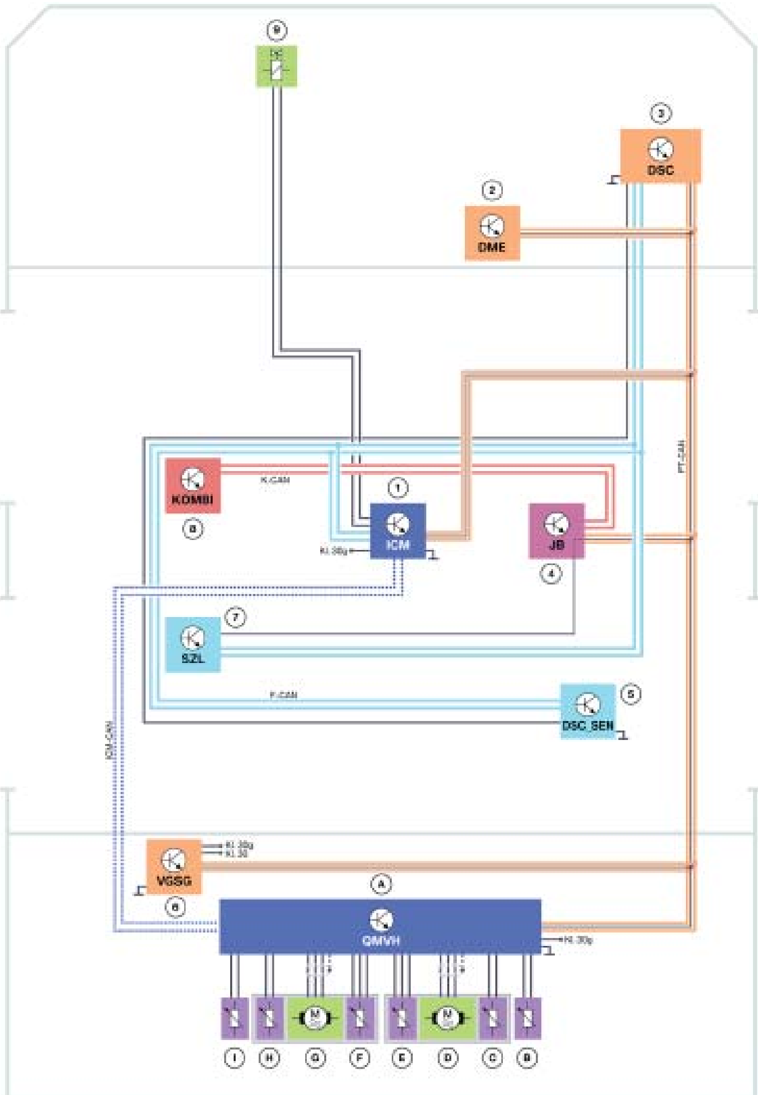
Index	Explanation
1	Dynamic stability control
2	DSC sensor
3	Transfer case
4	SZ steering column switch cluster
5	ICM control unit
6	Rear differential with superimposing gear units
7	QMVH control unit
8	Transfer box control unit
9	Superimposing gear unit, right
10	Angle drive with differential
11	Superimposing gear unit, left

This second diagram of the system overview focuses in particular on the new dynamic driving system, Dynamic Performance Control. With Dynamic Performance Control, a new system network will be introduced in the form of the Integrated Chassis Management. This will result in changes that affect the interaction of the dynamic driving systems.

The Active Steering is particularly affected by this, which is why the two equipment variants with/without Active Steering are both explained in the following pages.

NOTES PAGE

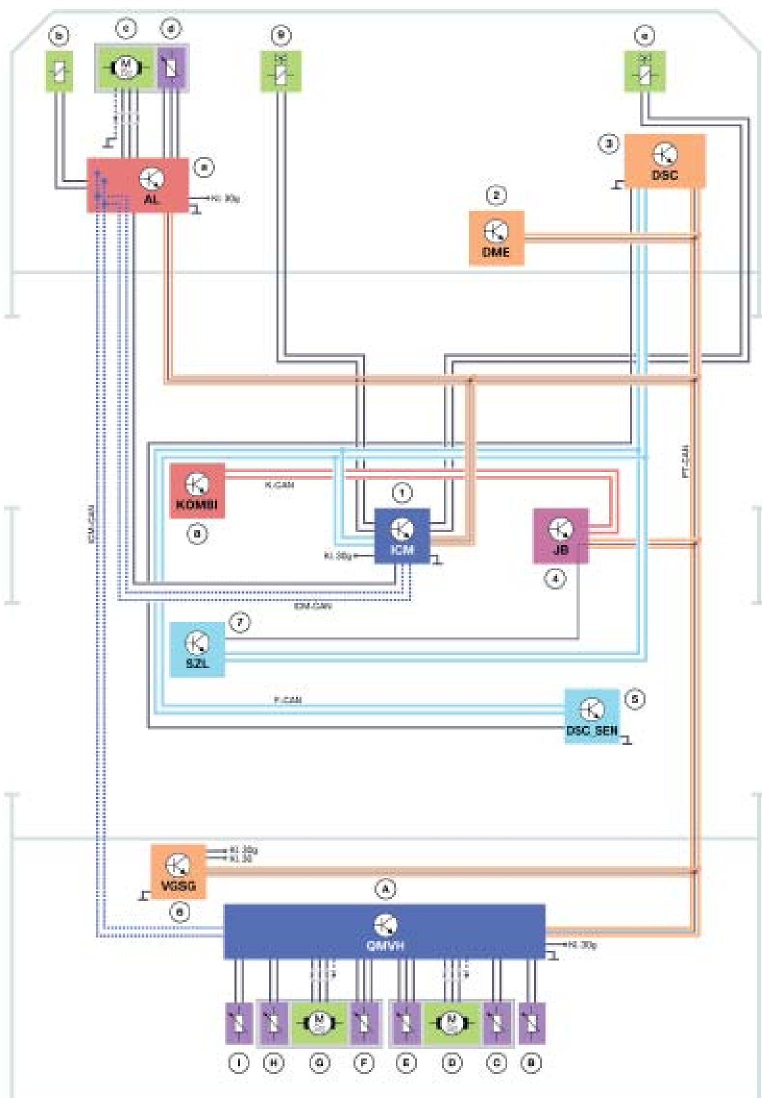
System Circuit Diagram for Dynamic Performance Control without Active Steering



Index	Explanation
1	Integrated Chassis Management
2	Digital Motor Electronics/Digital Diesel Electronics
3	Dynamic stability control
4	Junction box
5	DSC sensor
6	Transfer box control unit
7	Steering column switch cluster with steering angle sensor
8	Instrument cluster
9	EVV valve
A	Lateral torque distribution on the rear axle
B	Temperature sensor for the transmission oil in the superimposing gear unit, right
C	Temperature sensor for the electric motor in the superimposing gear unit, right
D	Electric motor in the superimposing gear unit, right
E	Motor position sensor in the superimposing gear unit, right
F	Motor position sensor in the superimposing gear unit, left
G	Electric motor in the superimposing gear unit, left
H	Temperature sensor for the electric motor in the superimposing gear unit, left
I	Temperature sensor for the transmission oil in the superimposing gear unit, left

An electronically controlled bypass valve (EVV) is fitted on all variants of the E71 in order to control the volumetric flow in the hydraulic circuit for the power steering. It is actuated by the ICM control unit.
If Active Steering is not fitted, the ICM-CAN is routed directly from the ICM control unit to the QMVH control unit.

System Circuit Diagram for Dynamic Performance Control with Active Steering



Index	Explanation
1	Integrated Chassis Management
2	Digital Motor Electronics/Digital Diesel Electronics
3	Dynamic stability control
4	Junction box
5	DSC sensor
6	Transfer box control unit
7	Steering column switch cluster with steering angle sensor
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9	EVV valve
A	Lateral torque distribution on the rear axle
B	Temperature sensor for the transmission oil in the superimposing gear unit, right
C	Temperature sensor for the electric motor in the superimposing gear unit, right
D	Electric motor in the superimposing gear unit, right
E	Motor position sensor in the superimposing gear unit, right
F	Motor position sensor in the superimposing gear unit, left
G	Electric motor in the superimposing gear unit, left
H	Temperature sensor for the electric motor in the superimposing gear unit, left
I	Temperature sensor for the transmission oil in the superimposing gear unit, left
a	Active Steering
b	Solenoid lock
c	Active Steering electric motor
d	Active Steering motor position sensor
e	Servotronic valve

The topology of the ICM-CAN bus system differs greatly between the two variants with/without Active Steering. If Active Steering is fitted, the ICM-CAM is routed from the ICM control unit to the AL control unit. The ICM-CAN is picked up in the AL control unit and forwarded to the QMVH control unit.

System Components

Rear Differential with Superimposing Gear Units

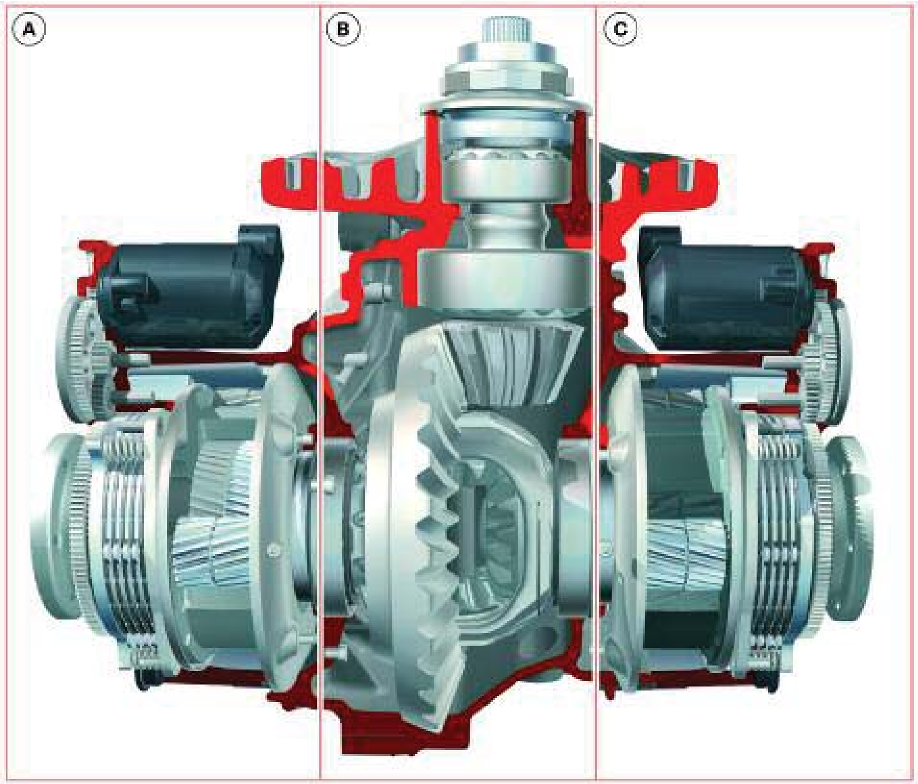
For Dynamic Performance Control, a rear differential is used that essentially consists of a conventional rear differential, supplemented by superimposing gear units on the left and right.

The only difference is the welded connection of the ring gear and pinion gear (previously bolted).

The two superimposing gear units are practically identical in terms of their structure, but differ slightly in terms of their detail. For example, the electric motors and planetary trains on the left or the right are different.

This rear differential also has three oil reservoirs, subdivided in a similar way to in the picture, which are vented by a common duct.

Design of the rear differential with superimposing gear units



Index	Explanation
A	Superimposing gear unit, left
B	Angle drive with differential
C	Superimposing gear unit, right

There are therefore three filler plugs and three drain plugs on this rear differential.

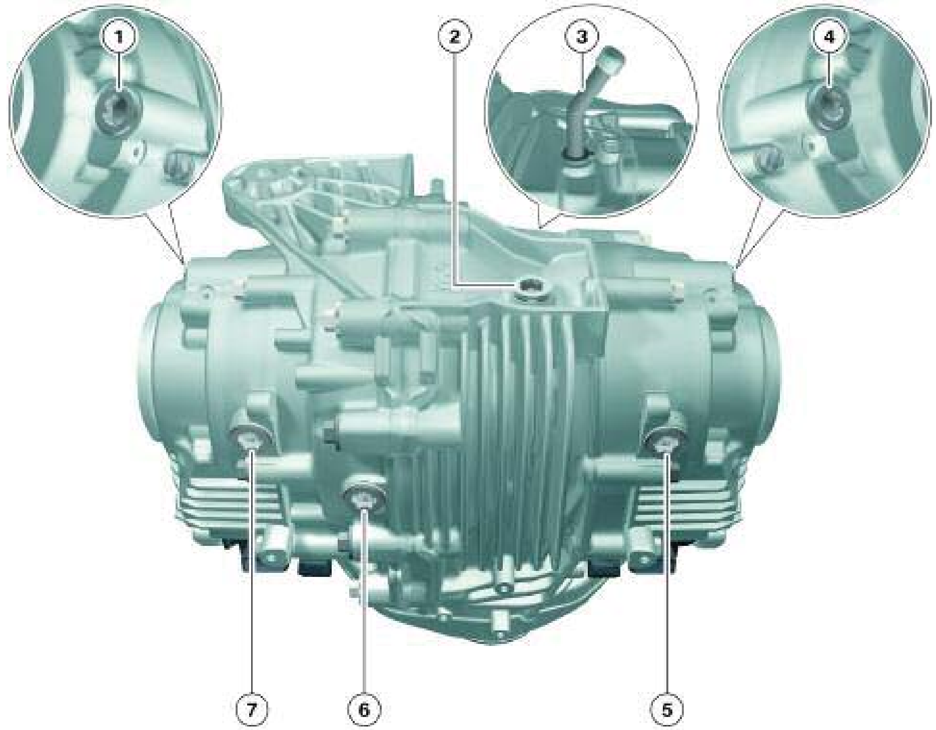
In the center part (angle drive with differential gear), the standard oil (hypoid oil) is used and, in the left and right superimposing gear units, a special ATF is used.

Longlife oils are provided as standard in the rear differential with superimposing gear units. There are some exceptions dependent on the service life/use of the unit.

All three reservoirs have a common vent on the top of the transmission case.

Note: The angle when the rear differential unit is removed and reinstalled must be no more than 45°. This could potentially cause the two types of oil to cross contaminate through the common vent.

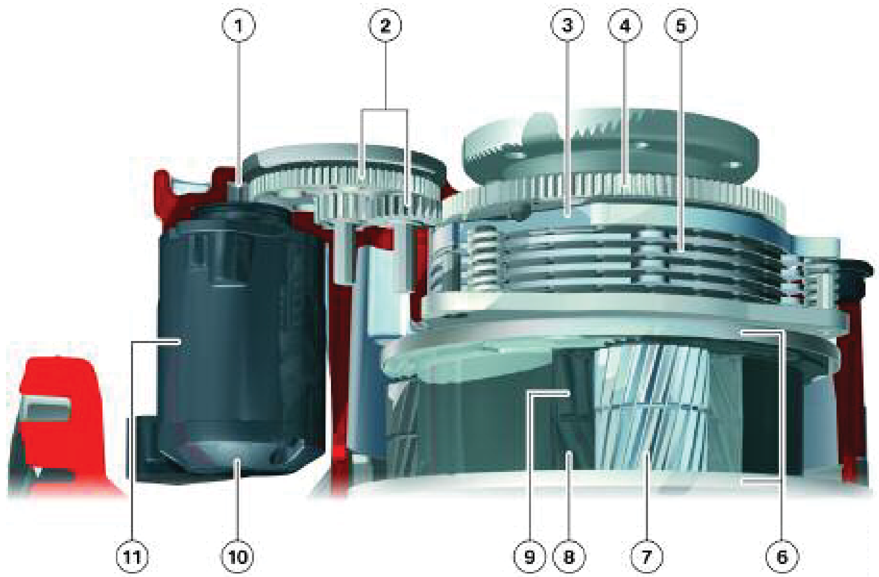
Oil reservoirs of the rear differential with superimposing gear units



Index	Explanation
1	Filler plug for the left superimposing gear unit
2	Filler plug for the angle drive with differential gear
3	Vent
4	Filler plug for the right superimposing gear unit
5	Drain plug for the right superimposing gear unit
6	Drain plug for the angle drive with differential gear
7	Drain plug for the left superimposing gear unit

Construction of the Superimposing Gear Units

The two superimposing gear units essentially consist of an actuator (electric motor), transmission gearing, a ball ramp, a multi-plate clutch and a planetary gear set. In contrast to standard planetary gear sets, this one does not contain a ring gear.



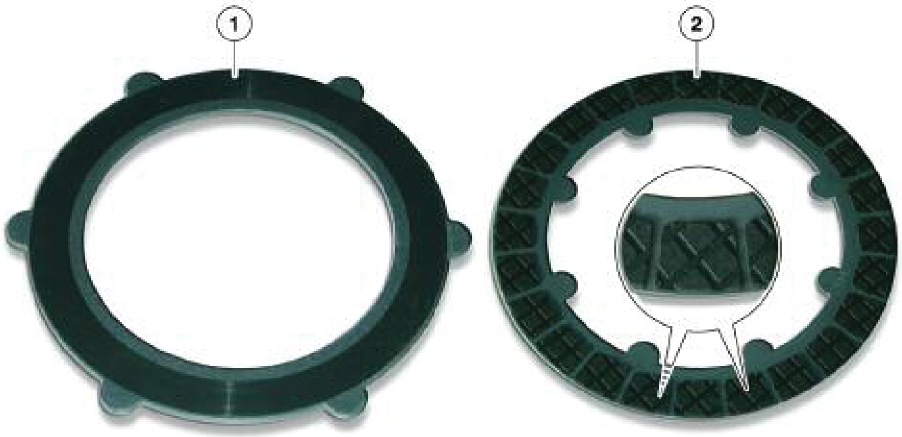
Index	Explanation
1	Electric motor drive pinion
2	Transmission gears
3	Ball-ramp pressure plate
4	Ball-ramp drive gear
5	Multi-plate clutch assembly
6	Planet carrier
7	Planetary gear
8	Inner sun gear
9	Outer sun gear
10	Motor position sensor
11	Right electric motor

Multi-plate Clutch and Ball Ramp

The multi-plate clutch and the ball ramp are designed in such a way that they are always de-energized if there is fault in the electric motor. In this event, the pressure spring assemblies now take on an important role between the ball ramp and the support plates.

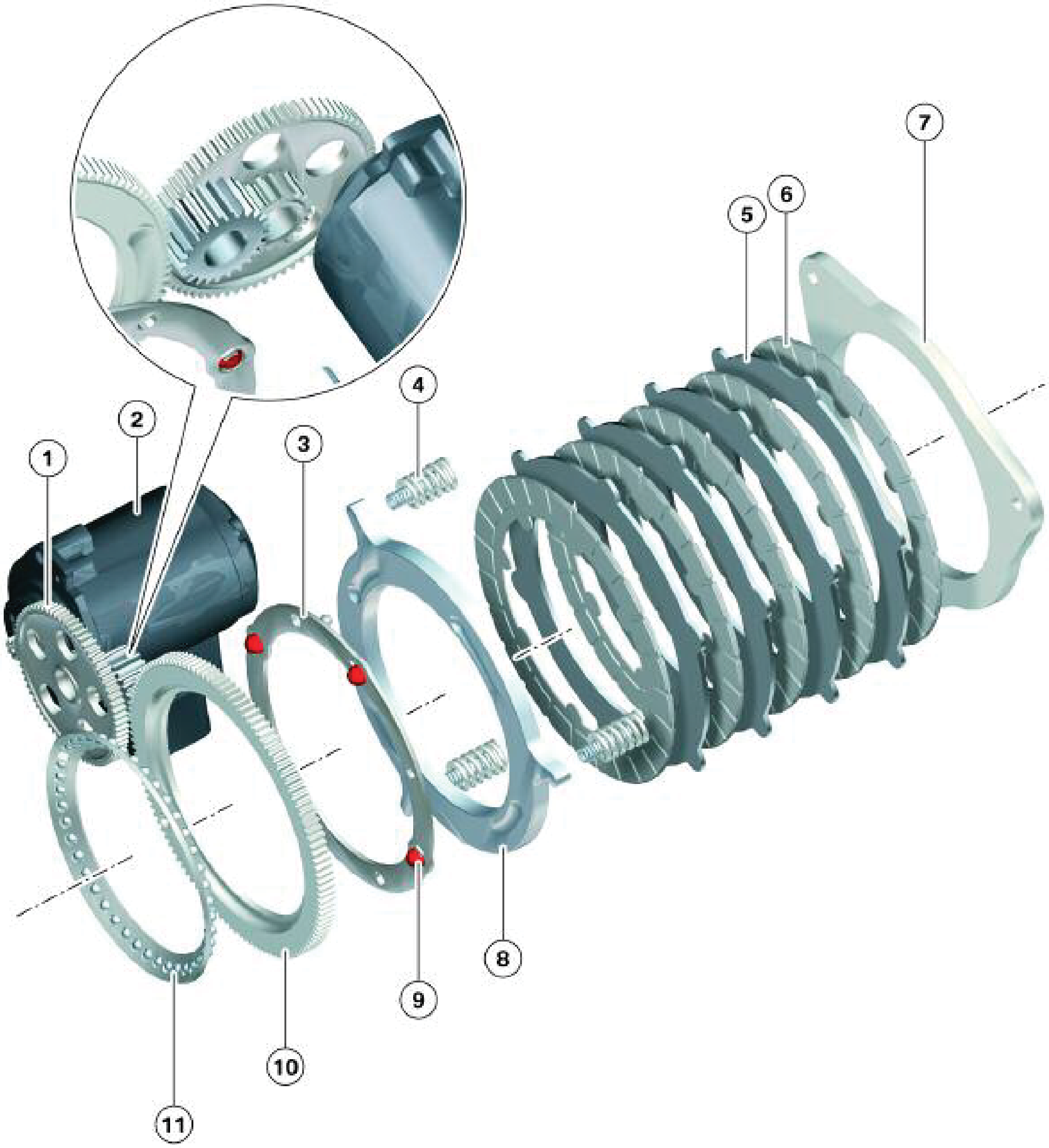
The pressure spring assemblies open the multi-plate clutch via the ball ramp and the freely rotating electric motor and hold it fully open. This ensures, among other things, that the loss of torque distribution is established in the event of a fault.

Construction of the multi-plate clutch



Index	Explanation
1	Plate carrier
2	Friction plate

Exploded view of the multi-plate clutch



Index	Explanation
1	Transmission gears
2	Left electric motor
3	Ball guide ring
4	Pressure spring assemblies
5	Plate carrier
6	Friction plate
7	Support plate
8	Ball-ramp pressure plate
9	Balls (4x)
10	Ball-ramp drive gear
11	Ball bearing for left output shaft

Electric Motors

These are three-phase asynchronous motors.

The three-phase voltage is generated by the QMVH control unit. This creates a rotating electromagnetic field around the metallic rotor which generates torque in the rotor.

An asynchronous-motor design was selected because it guarantees a high level of power with a simple construction.

Furthermore, the shaft of an asynchronous motor can be moved freely when the phase voltage is switched off. This is an integral part of the safety concept, because the phase voltage is switched off in the event of a fault.

The left and right electric motors have different constructions. The phase voltage and temperature sensor connectors (2) are also coded differently. This will prevent the two motors from being mixed up or incorrectly connected.

The two electric motors are connected to the superimposing gear units via the screw connections for the motor mounting (4). The electric motors thus have contact with the oil supply for the superimposing gear units.

Because the bearing (6) is not sealed, not only the pinion but also the entire rotor for the electric motor rotate in the oil. For this reason, the following housing seals are fitted to the electric motors:

- Sealing ring (5)
- Sealing ring at the join with the motor position sensor (not shown)
- Seal at the connector for the phase voltage and temperature sensor (2), see the Sensor system section.

Left electric motor

Index	Explanation
1	Motor position sensor connector
2	Connector for phase voltage and temperature sensor
3	Screw connection for bearing cap
4	Screw connection for motor mounting
5	Seal
6	Bearing
7	Electric motor pinion

Note: Please refer to Service Information section for important procedures to follow when replacing motors.

Sensor System

The following sensors, integrated in the Dynamic Performance Control components, are therefore an integral part of the system.

- Temperature sensors for the electric motors.
- Temperature sensors for the superimposing gear unit transmission oil.
- Motor position sensors.

There is one of the sensors mentioned above for each superimposing gear unit and each electric motor.

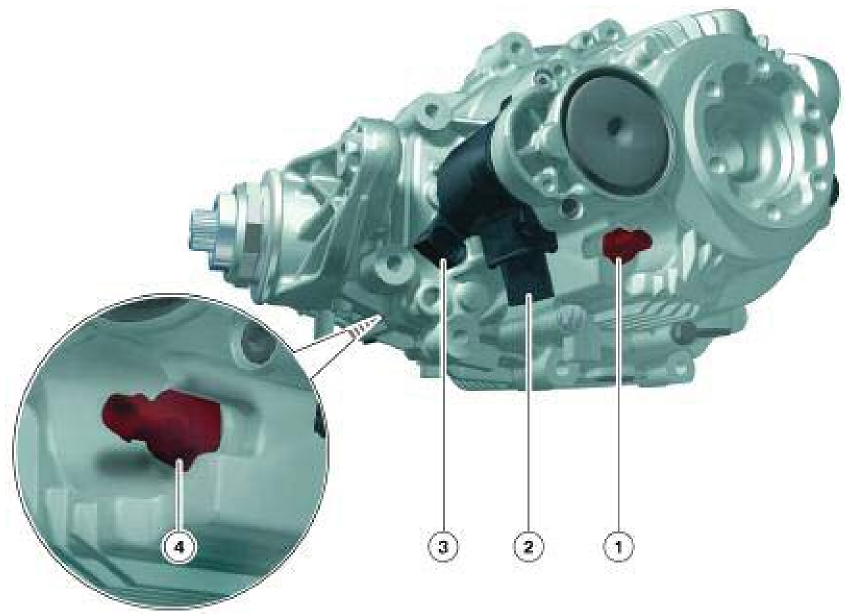
Motor Position Sensor

The motor position sensor is located on the rear of the electric motor (the side opposite the pinion). The sensor is identical to the one used for the Active Steering actuating motor. The sensor thus works according to the magnetoresistive principle and transmits the data digitally to the QMVH control unit via a two-wire line.

Oil Temperature Sensors

The two sensors for determining the temperature of the transmission oil in the two superimposing gear units are arranged symmetrically on the two sides.

Connector and sensors for the transmission oil temperature



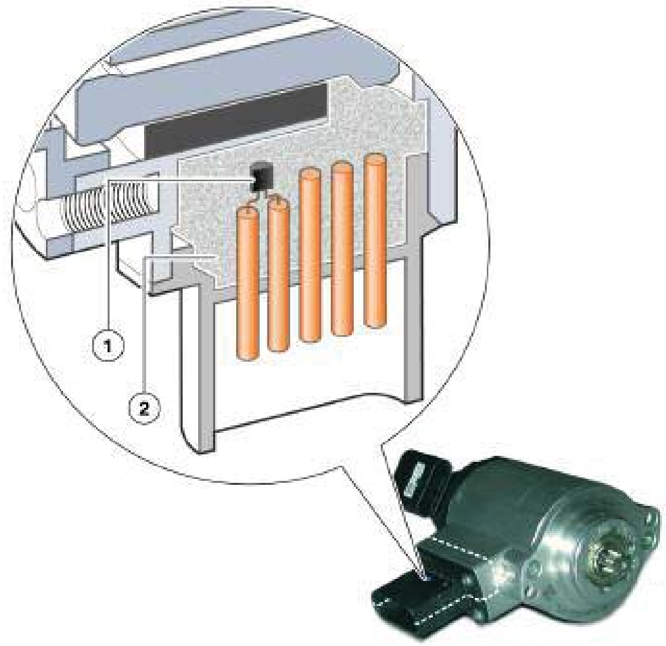
Index	Explanation
1	Connector for the left transmission oil temperature sensor
2	Connector for phase voltage and temperature sensor for the left electric motor
3	Connector for the left motor position sensor
4	Connector for the right transmission oil temperature sensor

Electric Motor Temperature Sensor

The temperature sensor for the electric motor is located in the immediate vicinity of the connector through which the electric motor is supplied with the phase voltage.

The temperature sensor for the electric motor (1) is a temperature-dependent resistor. The QMVH control unit measures the resistance and thus determines the temperature that is present in the electric motor. In the diagram, you can see the sealant (2) that was mentioned earlier which seals the housing to the connector. This prevents oil from escaping at this location. At the same time, the sealant performs the task of a heat conductor, so that the temperature sensor is exposed to practically the same temperature as the rest of the components of the electric motor.

Temperature sensor for the electric motor



Index	Explanation
1	Temperature sensor for the electric motor
2	Sealant

Mechanical Interfaces

The rear differential with superimposing gear units for Dynamic Performance Control is bolted onto the rear axle carrier in the same way as the conventional rear differential.

The propeller shaft is fixed to the rear differential with a double nut as on the E70.

The output shafts are fitted in different ways on the E71 and E70.

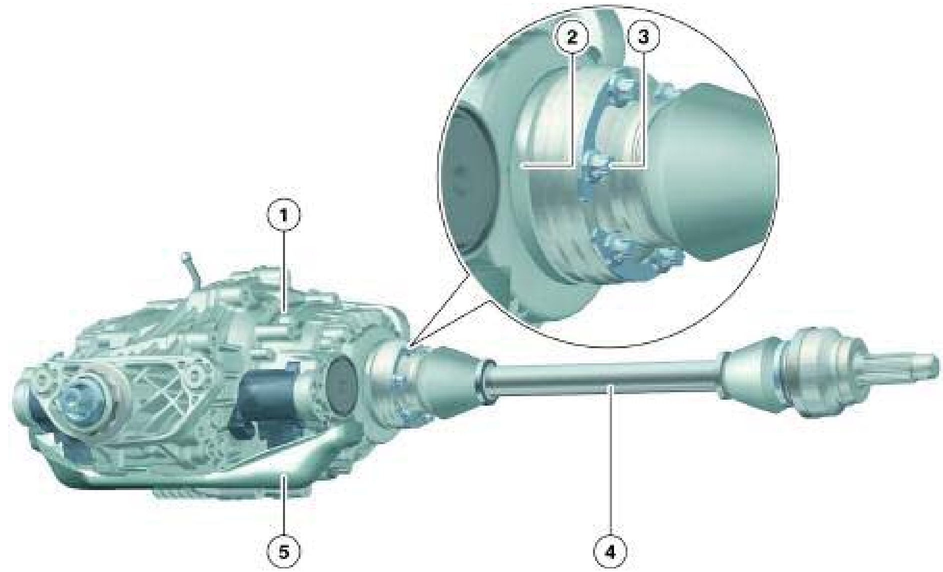
On the E70, the output shafts are inserted in the rear differential.

On the E71, the actual output shafts are bolted to the output shaft flange.

The heat conduction and protective plate (5) shown in the diagram has the following tasks:

- Protects the connectors on the electric motors from stone impact.
- Diverts heat from the exhaust system so that it does not heat up the rear differential too much.

Fitting of the left output shaft in the E71



Index	Explanation
1	Rear differential with superimposing gear units
2	Output shaft flange
3	Bolting of output shaft to output shaft flange
4	Output shaft
5	Heat conduction and protective plate

Workshop Exercise - QMVH Rear Differential

Using an instructor designated mockup or vehicle, answer the questions below.

Locate the filler and drain plugs on the QMVH unit. Make a triangle around the filler plugs and circle the drain plugs.

Side View

Bottom View

Rear View

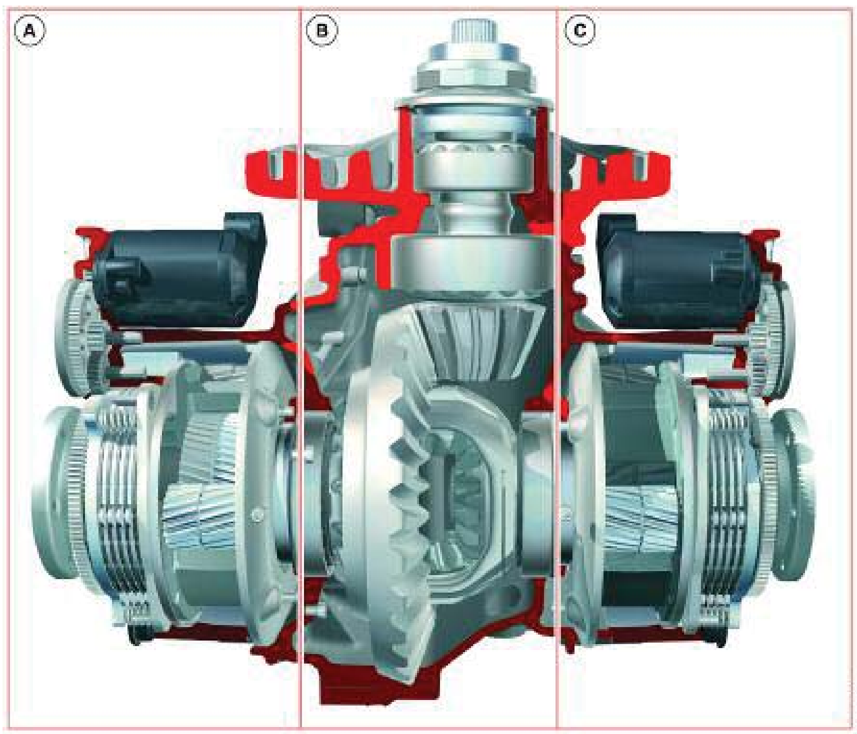
How many drain/filler plugs are there? Why?

Description	Quantity on Unit
Δ **Fill Plug**	
O **Drain Plug**	

Does the oil in the left/right (superimposing gear section) of the unit have to be replaced? If so, when?

Section of Rear Differential	Type of Fluid	BMW Part Number
QMVH Superimposing Gears		
Conventional Differential		

Workshop Exercise - QMVH Rear Differential (continued)



Why is it important to remember that the QMVH unit is actually three components in one when servicing the oil?

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When replacing the QMVH unit, what precautions must be taken with reference to the vent lines on the unit?

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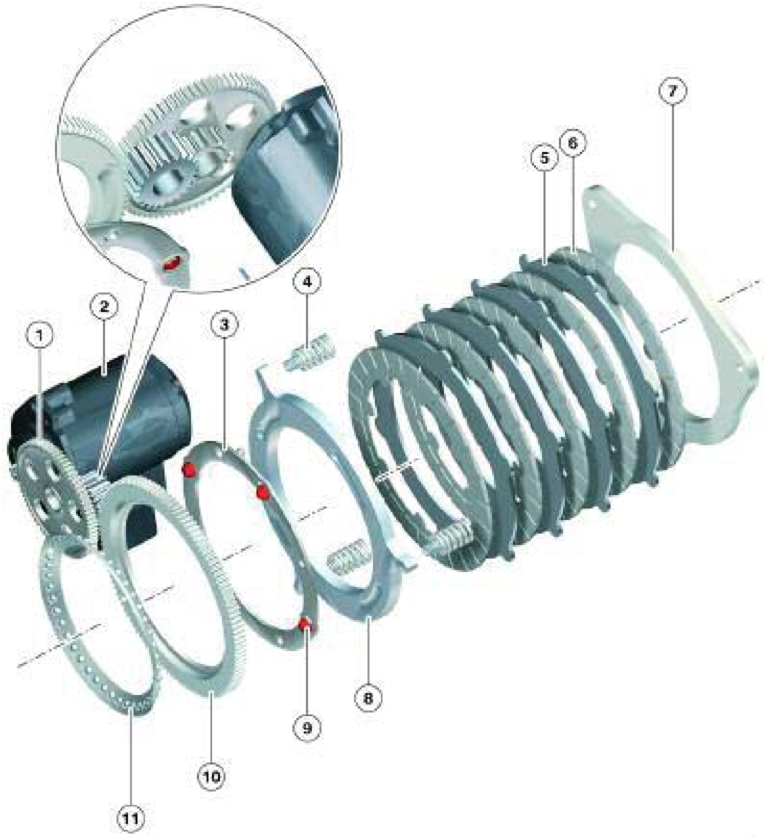


What is the function of item number 4 in the diagram above?

____

____

Examine the electronic motors on the QMVH rear differential. Are they interchangeable?

❑ Yes ❑ No

Bus Systems

The dynamic driving systems communicate via the usual bus systems, such as the Powertrain CAN (PT-CAN) and the Chassis CAN (F-CAN).

The F-CAN still performs the function of transmitting pure sensor signals. The signals from the DSC sensor and the steering wheel sensor in the steering column switch cluster have top priority. Despite the fact that the PT-CAN and F-CAN work at a high bit rate of 500 kbps, they would have been overloaded by the signals from the new ICM and QMVH control units. For this reason, a new sub-bus, the ICM-CAN, has been introduced.

The ICM-CAN is a sub-bus for the dynamic driving systems and connects the ICM, AL and QMVH control units. It is a two-wire bus on which data is transmitted at 500 kbps. The two terminating resistors, each with 120 Ω, are located in the ICM and QMVH control units.

The ICM-CAN cabling in the vehicle varies considerably between the two variants with/without Active Steering.

If Active Steering is fitted, the ICM-CAN is routed from the ICM control unit to the AL control unit. The ICM-CAN is picked up in the AL control unit and forwarded to the QMVH control unit.

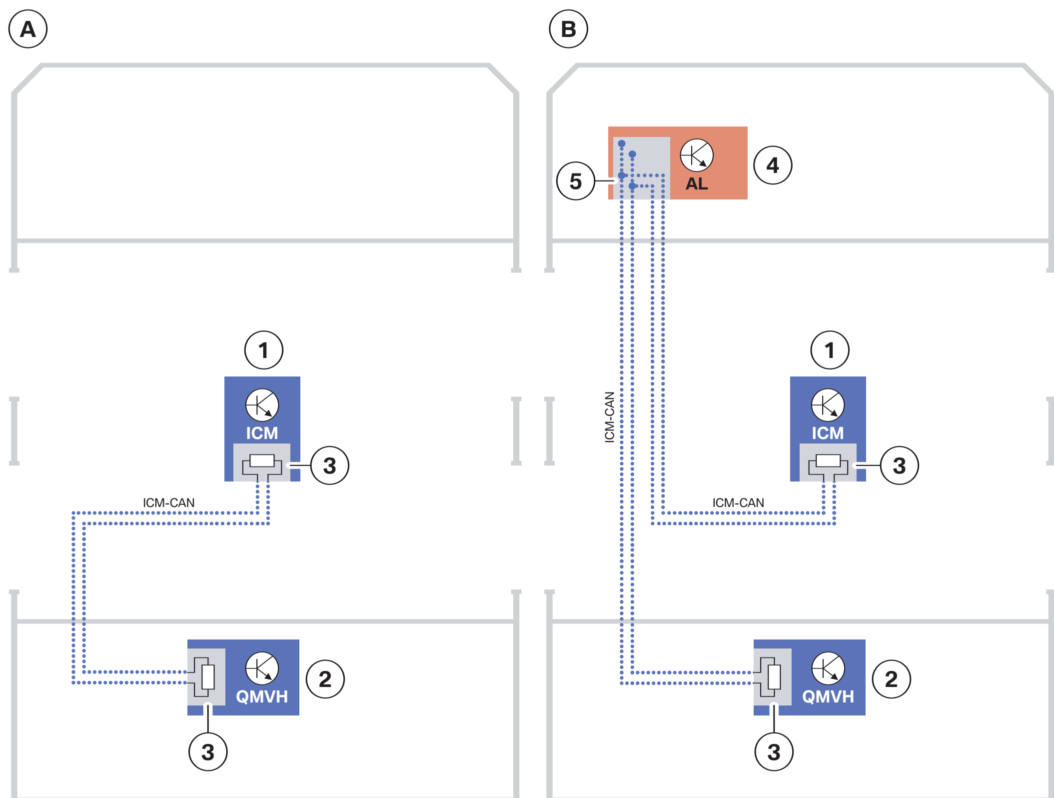
If Active Steering is not fitted, the ICM-CAN line is routed directly from the ICM control unit to the QMVH control unit.

These control units use the ICM-CAN to exchange setpoint values and actual values, as well as status signals. These signals are only required locally for implementing the Dynamic Performance Control and Active Steering functions.

In contrast, signals that the dynamic driving systems exchange with other control units are still transmitted via the PT-CAN. The PT-CAN is also the bus system via which the ICM, AL and QMVH control units communicate with the diagnostic system.

The ICM control unit does not therefore perform the function of a diagnostics gateway.

Layout variants for the ICM-CAN in the E71



Index	Explanation
A	Without Active Steering
B	With Active Steering
1	Integrated Chassis Management
2	Lateral torque distribution on the rear axle
3	ICM-CAN terminating resistor
4	Active Steering
5	ICM-CAN (picked up and forwarded)

QMVH Control Unit

Design

The QMVH control unit is fitted at the rear right of the luggage compartment.

As you can see from the following diagram, it is a dual-processor control unit. Power semiconductors are also integrated in the control unit which function as output stages.

Each processor is responsible for controlling one of the electric motors. In addition, each processor monitors the computed results of the other in order to meet the high safety requirements. The output stages can be separated before a fault has any critical effects.

The output stages are used to generate the phase voltages and transport the energy required to control the electric motors.

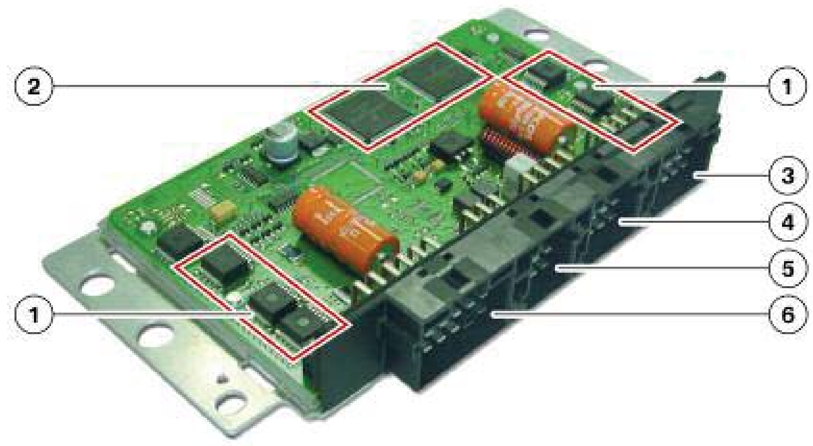
Because the electric motors are three-phase asynchronous motors, the three phases must be operated with alternating voltage. The phases are generated by high-frequency pulsing of the DC voltage present in the vehicle electrical system.

The high-frequency pulsing creates the risk that electromagnetic interference will be emitted. This would have a detrimental effect on radio reception, because the associated aerials are located near to the installation location of the QMVH control unit.

For this reason, the lines along which the electric motor phases are actuated are shielded. The ground connection is located on the connector for the QMVH control unit.

There is also an ground connection from the wiring harness to the rear axle carrier.

QMVH control unit without housing cover



Index	Explanation
1	Output stages from power semiconductors
2	Two processors
3	Pin socket [right superimposing gear unit]
4	Pin socket [vehicle electrical system]
5	Pin socket [unassigned]
6	Pin socket [left superimposing gear unit]

The two outer pin sockets (3) and (6) are used to connect the wiring harnesses that lead to the superimposing gear units.

Pin socket (4) connects the control unit to the vehicle electrical system: the supply voltage, PT-CAN and ICM-CAN are connected here.

Pin socket (5) is not assigned and remains unused.

Operation

The QMVH control unit receives a request from the ICM control unit to transfer a certain amount of torque to the left or right rear drive wheel. The control unit must convert this setpoint value into phase voltages for the electric motor to be actuated. The following calculation steps are required for this:

- Deciding which superimposing gear unit needs to be activated. The side that should receive more of the available torque must be activated.
- Converting the torque to be transferred into a braking force at the superimposing gear unit.
- Determining the necessary adjustment path of the plates from the braking force that the plate assembly must generate.
- Calculating the motor rotation angle to achieve the required adjustment path of the plates.
- Determining the amplitude and progression of the three phase voltages.

During the adjustment process, the QMVH control unit uses the motor position sensor to measure whether and how far the electric motor has already moved. Once the calculated specified angle is reached, the actuation is changed so that the rotational angle achieved is maintained. A motor position regulation therefore takes place. The regulation principle is similar to that for Active Steering.

The QMVH control unit also carries out monitoring functions. This allows faults in the electronics and in the actuating elements to be detected which cause the function to be deactivated. In the event of a fault, the lines to the electric motors are disconnected. They are then de-energized and can no longer execute undesirable adjustment processes.

The multi-plate clutches also open, so that a previously active torque transfer is withdrawn.

The rear differential (and therefore the entire system) thus behaves like a conventional differential in the event of a fault.

As well as detecting faults, the QMVH control unit also monitors the signals from the temperature sensors on the rear differential. A protective function is thus implemented, which reduces the actuating element controls if the temperature is too high. This is intended to counteract any further heating (see also the Functions section). Both the temperatures in the electric motors and the temperatures of the transmission oils in the two superimposing gear units are taken into consideration.

ICM Control Unit

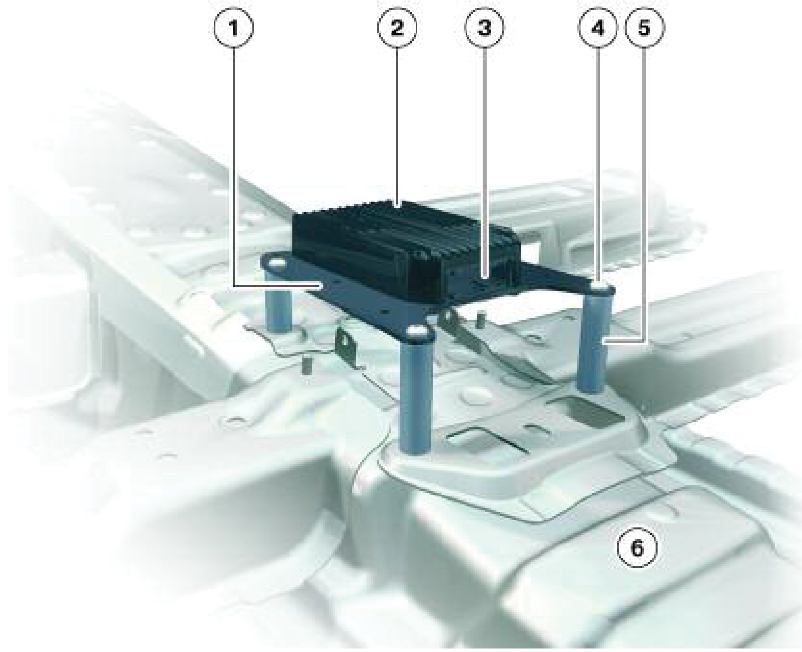
The ICM control unit is installed on the transmission tunnel (6). The lower section of the housing is bolted to the body work using spacer sleeves (5). The upper section of the housing has a ribbed structure for better heat dissipation. The ICM control unit has only one pin socket, which is used to make contact with the supply voltage, the bus systems and the control lines.

The ICM control unit only contains output stages for the steering proportional valve (EVV - electronically controlled bypass valve) and the Servotronic valve.

The ICM control unit is connected to three bus systems: the PT-CAN, the F-CAN and the new ICM-CAN.

The ICM control unit makes calculations that have a decisive influence on the vehicle behavior. This results in both high safety requirements and a need for a large calculating capacity. For these two reasons, the ICM control unit is equipped with two processors.

Installation location of the ICM control unit



Index	Explanation
1	Lower section of housing
2	Upper section of housing
3	Connector
4	Mounting bolt
5	Spacer sleeve
6	Transmission tunnel

Active Steering

Virtually all of the components of Active Steering in the E71 are identical to those in the E70. To be precise,

- the electric motor with motor position sensor,
- the proportional valve (electronically controlled bypass valve, EVV) and
- the Servotronic valve are identical in the two vehicle models. The AL control unit has a different construction in the E71 and is only designed as an actuating control unit.

Active Steering Control Unit

The AL control unit is located at the front left in the A-pillar extension under the wheel arch trim.

It is a dual-processor control unit. Power semiconductors are also integrated in the control unit which function as output stages. The dual-processor concept was selected in order to meet the high safety requirements.

The output stages (2), consisting of power semiconductors, are used to generate the phase voltages and transport the energy required to control the actuating motor.

Because this is a three-phase synchronous motor, the three phases must be operated with alternating voltage.

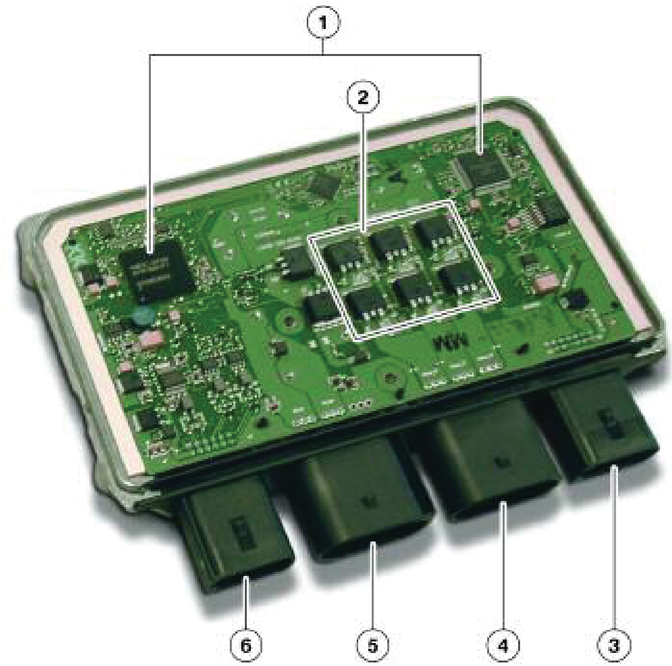
The phases are generated by high-frequency pulsing of the DC voltage present in the vehicle electrical system. For this reason, shielding is also used here. The shielding connects the electric motor to ground via the wiring harness to the body work.

Connector (3) accommodates signal lines between the control unit and actuating element for Active Steering. These are the control lines to the solenoid lock and the signal lines for the motor position sensor.

Load is supplied to Active Steering via the connector (4). This DC voltage is converted into the phase voltages by the output stages in the control unit and sent to the electric motor at connector (5).

Connector (6) contains the contacts via which the control unit is supplied with power and those for connecting the two bus systems, PT-CAN and ICM-CAN.

Active Steering control unit without housing cover



Index	Explanation	Index	Explanation
1	Processors	4	Connector [voltage supply]
2	Output stages	5	Connector [phase voltages]
3	Connector [signal lines]	6	Connector [vehicle interface]

Note: The control units of the E70 and E71 cannot be interchanged.

ARS

At SOP for the E71 in April 2008, certain alterations will also be made simultaneously in the E70.

Key modifications to the ARS:

- Discontinuation of the additional ARS lateral acceleration sensor
- Discontinuation of the two pressure-relief valves on the front axle oscillating motor
- Discontinuation of the two exterior pulsation dampers on the front axle oscillating motor.

Control Unit

The ARS control unit is located in the vehicle interior near the right-hand A-pillar.

The ARS control unit is supplied with power via terminal 30 and is protected by a 10 A fuse. The ARS control unit is activated exclusively by the Car Access System (CAS) on a CAN wake-up line after "ignition ON".

A vehicle authentication process takes place when the system is started. This compares the vehicle identification number from CAS with the vehicle identification number which is encoded in the ARS control unit.

Then the ARS control unit's hardware and software are checked.

All outputs (valve solenoids and sensors) are subjected to a comprehensive check for short circuits and circuit breaks. If there is a fault, the system switches the actuators to a safe driving mode.

The ARS control unit switches off if there is undervoltage or overvoltage.

The ARS control unit learns the offset for the steering angle and the lateral acceleration during start-up and during driving.

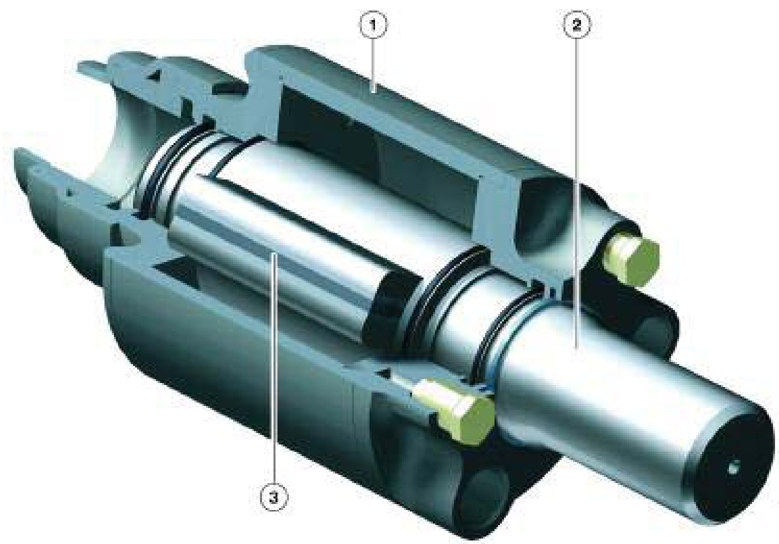
Active Anti-roll Bar

The oscillating motor and the oscillating motor housing are joined by one half of the anti-roll bar.

The active anti-roll bar consists of the oscillating motor and the anti-roll bar halves fitted to the oscillating motor, with press-fitted roller bearings for their connection to the axle carriers. The use of roller bearings ensures optimum comfort thanks to better response and reduced control forces.

A thin coating of grease on the roller bearing does not impair the function of the active anti-roll bar.

Similarly, a totally new inner pulsation damping system is introduced, which is integrated into the construction of the oscillating motor shaft. This eliminates the need for the two pressure relief valves on the front motor.



Index	Explanation
1	Oscillating motor housing
2	Inner pulsation damping system
3	Oscillating motor shaft

EMF

Similarly to the E70 , the E71 is fitted as standard with an electro-mechanical parking brake (EMF). On E71 and E70 vehicles produced from 10/07, this dynamic emergency brake and parking brake is complemented by the automatic hold function which functions the same as on the E65/E66.

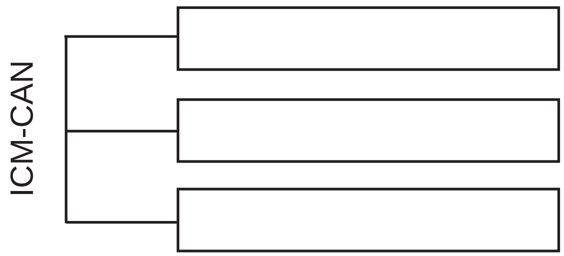
The Automatic Hold button is located in the center console.

Index	Explanation	Index	Explanation
1	EMF button	2	Automatic hold function button

Workshop Exercise - ICM-CAN

Using an instructor assigned E71 vehicle, pin out the ICM-CAN and answer the following questions.

1) *Using the workbook or system wiring diagram, fill in the missing modules of the ICM-CAN.*



2) Disconnect all the connections to the QMVH control unit and measure the resistance between ICM-CAN High and ICM-CAN Low. *Circle the best possible answer.*

60Ω   100Ω   120Ω   240Ω

3) In which control modules are the terminal resistors located for the ICM-CAN? *Circle the best possible answer.*

QMVH

ICM

AL/AFS

DSC

4) Where are the following control units located?

QMVH ______________________

ICM ______________________

AL/AFS ______________________

5) Locate the QMVH Control Module and pin out the ICM-CAN. *Draw the oscilloscope pattern displayed in the in the space provided below.*

Integrated Chassis Management (ICM)

A new feature in the E71 is the continuation of the concept of a higher-level dynamic driving control with Integrated Chassis Management.

The introduction of the ICM control unit is rather secondary. Of more significance, is the fact that all the dynamic driving systems in the vehicle can be coordinated in a more harmonized way using the ICM.

The previous approach of using one control unit for each main direction of movement has not been applied in the E71. Instead, the ICM control unit coordinates both longitudinal and lateral dynamic processes. In concrete terms, this means that Active Steering and the new Dynamic Performance Control function are controlled by the ICM.

However, this does not mean that the ICM has exclusive decision-making powers over the type and degree of the intervention of all the dynamic driving systems. One reason for this is that the DSC and xDrive systems used in the E70 are to be largely adopted in the E71. The E71 therefore shares the following similarities with the E70:

- If the vehicle needs to be restabilized when it is in its limit range, the DSC calculates the need for the brakes to be applied and applies them. This is also the case in the E71 despite the coordination function of the ICM.
- The DSC calculates the longitudinal distribution of the drive torque for xDrive and transmits the setpoint value to the transfer case control unit. There, the drive torque is distributed between the front and rear axles through activation of the multi-plate clutch.

The DSC therefore remains the determining control unit in the E71 when it comes to stabilizing the vehicle's behavior in the limit range. In this case, the DSC sends commands to the ICM to cease control by Dynamic Performance Control. However, while the vehicle is stable, the ICM has full decision making authority over the activation of Dynamic Performance Control.

The Active Steering functions (in particular the yaw-rate control) are not affected by this withdrawal of control. They continue to be implemented even if the vehicle's behavior is unstable, because they help to stabilize it.

The Vertical Dynamics Management (VDM) is still responsible for controlling the vertical dynamics. Signals regarding the current driving situation are naturally exchanged between the ICM and VDM.

Monitoring the Vehicle Status

The Integrated Chassis Management (ICM) control unit calculates the current driving situation from the signals listed below. This refers only to the longitudinal and lateral dynamic driving status.

- Wheel speed signals from all four wheels
- Longitudinal acceleration
- Lateral acceleration
- Yaw rate

The ICM control unit thus knows how the vehicle is actually moving at that moment.

To be able to optimize the vehicle behavior, the dynamic driving systems require information about how the driver wishes the vehicle to move. The driver's command is determined from the following signals:

- Accelerator pedal angle, current engine torque and gear ratio
- Application of the brake pedal and current brake pressure
- Steering angle

The ICM control compares the driver's command and the current actual movement of the vehicle and calculates whether intervention from the Active Steering and Dynamic Performance Control systems is necessary and what form this should take.

Coordinated Intervention by the Dynamic Driving Systems

Intervention by dynamic driving systems that operate in the longitudinal and lateral directions have the following objectives:

- To optimize the rotational motion of the vehicle about the vertical axis by effecting a yaw moment. This will increase the stability and/or the agility, depending on the driving situation.
- To improve the traction of the vehicle.

The Integrated Chassis Management allows these objectives to be achieved to a greater extent. The ICM acts as a coordinator and distributes the tasks to one or more systems.

To date, the following options have been available (and continue to be) for intervention to achieve the objectives stated above. The corresponding dynamic driving systems are indicated in brackets:

- Individual application of the wheel brakes (ASC+T, DSC)
- Adjustment of the current engine torque (ASC+T, DSC, MSR)
- Distribution of the drive torque between the rear and front axles (xDrive)
- Adjustment of the steering angle of the front wheels, regardless of the driver's input (Active Steering).

In the E71, a further option for improving the traction and optimizing the rotational motion is available for the first time. The Dynamic Performance Control allows the drive torque to be distributed in a controlled way between the driven rear wheels.

The coordinated interventions by the systems with the help of the Integrated Chassis Management bring about several advantages.

In some driving situations, it can prevent more than one system providing the same intervention.

For example, systems such as Dynamic Performance Control act as an enhancement to xDrive before the unstable driving situation even occurs. This happens without the driver being aware of it and avoids further intervention by Active Steering or Dynamic Stability Control.

Active Steering in the ICM Network

The functions of Active Steering that are perceptible to the customer in the E71 are identical to those in the E70. Active Steering also provides:

- a variable steering-transmission ratio that changes according to the vehicle's road speed and
- Yaw-Rate Control Plus (GRR+), which is used to stabilize steering interventions, not only when the vehicle is oversteering, but also when it is being braked on surfaces with various friction coefficients.

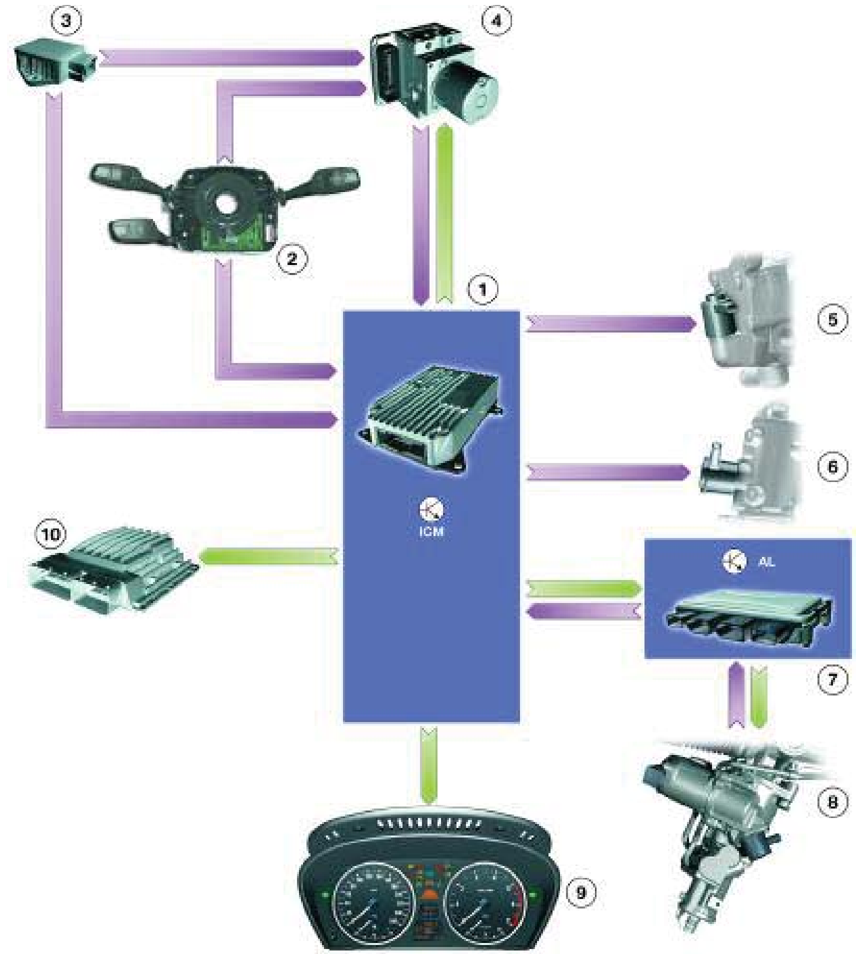
Just some of the parameters have been specifically adapted for the new E71 vehicle type.

The distribution of the functions between the control units and thus their interaction have changed. This is due to the new ICM control unit network in the E71.

The Integrated Chassis Management is the control unit in which the higher-level dynamic driving functions for Active Steering are calculated. As already described, the current driving situation is analyzed. The input variables for this are provided by:

- the steering column switch cluster (steering angle and steering-angle speed),
- the DSC sensor (yaw rate, lateral acceleration and longitudinal acceleration) and
- Dynamic Stability Control (wheel speeds) In addition, the driver's directional input is analyzed using the steering angle and the steering-angle speed (both signals from the steering column switch cluster).

Active Steering IPO



Index	Explanation	Index	Explanation
1	Integrated Chassis Management	6	Servotronic valve
2	SZL with steering angle sensor	7	Active Steering (control unit)
3	DSC sensor	8	Active Steering (actuator)
4	Dynamic stability control	9	Instrument cluster
5	Proportional valve (EVV)	10	Engine control system (DME)

The Integrated Chassis Management uses the current driving situation and the driver's directional input to calculate the individual setpoint values for the variable steering transmission ratio and the Yaw-Rate Control Plus. Once these have been prioritized, the ICM provides a resulting setpoint value. This is a specified angle to which the front wheels should be adjusted.

The Active Steering control unit receives this setpoint value and has the principal task of controlling the actuating elements such that the setpoint value is achieved. The Active Steering control unit is therefore purely an actuating control unit. This is the main difference from the previous implementation of Active Steering. There, the control unit not only controlled the actuators, but also calculated the higher-level regulating functions.

In order to ensure that the setpoint value is applied, Active Steering control unit reads the signal from the motor-position sensor. This additional steering angle for Active Steering is also communicated to the ICM control unit and then to the DSC control unit.

To remain consistent with the E70, the DSC control unit in the E71 also calculates the cumulative steering angle from the steering angle and the Active Steering steering angle.

The DSC control unit provides the cumulative steering angle to the other control units via the PT-CAN.

All variants of the E71 equipped with Active Steering automatically receive the Servotronic function. This function is controlled by the ICM control unit.

All variants of the E71 steering system also contains a proportional valve that is also controlled by the ICM control unit. The valve is known as an electronically controlled bypass valve (EVV).

The volumetric flow generated by the power steering pump is distributed between the steering valve and a bypass valve according to the level of power steering assistance required. This distribution is infinitely variable.

The less power steering assistance required, the more hydraulic fluid is diverted to the bypass circuit. Because the hydraulic fluid in the bypass circuit has no task to perform, it means that the power steering pump consumes less power. In this way, the proportional valve has a hand in reducing fuel consumption and CO2 emissions.

ICM Interfaces

The ICM control unit has two further interfaces with partner control units for the Active Steering function. These are:

- Instrument cluster
- Engine control system

Instrument Cluster

If the ICM control unit detects a fault in the Active Steering system (faulty input signal, faults in the control unit or in the Active Steering actuator), it activates the usual steering warning lamp and the associated Check Control message. This request is implemented by the instrument cluster.

Engine Control Module

If there is a high level of steering activity, in particular at low road speeds, the cooling requirement in the hydraulic system increases.

To prevent overheating, the ICM control unit can ask for the speed of the electric fan to be increased. This request is sent via the PT-CAN to the engine control system, because the latter directly controls the electric fan.

Classroom Exercise - Component Functions and Operation

Using the workbook material, please complete the following table:

Component or Function	Module responsible for Logic or Processing	Module responsible for Actuation or Output
EDC		
AL/AFS		
DPC/QMVH		
xDrive		
DSC		
ASC		
ABS		
MSR		
Automatic Hold		
EVV		
Servotronic		
ARS		
EHC		
Total Steering Angle		N/A

Dynamic Performance Control

Distribution of the Drive Torque (xDrive w/o DPC)

The BMW xDrive all-wheel-drive system regulates the variable distribution of the drive torque between the front and rear axles, resulting in a longitudinal distribution of the drive torque. In the current xDrive generation, the distribution is performed by an adjustable multi-plate clutch. xDrive helps to improve the traction and stability of the vehicle.

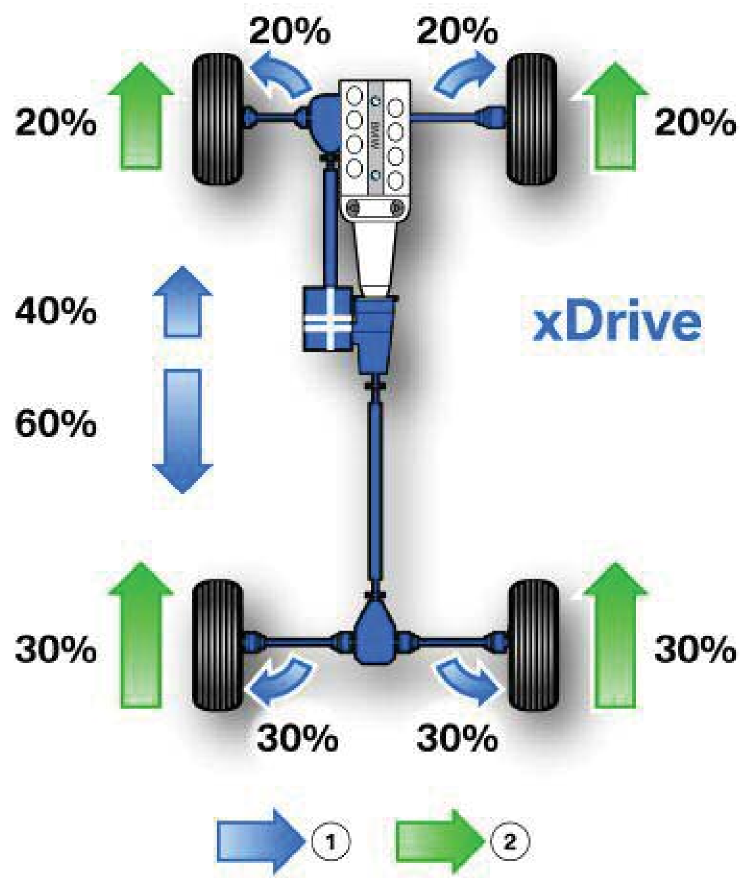
In the situation shown, the distribution of the drive torque by xDrive is the standard distribution. 40% is distributed to the front axle and 60% to the rear axle.

The front and rear axle transmissions distribute the drive torque equally to both sides. In terms of driving force, 20% is available at each front wheel and 30% at each rear wheel.

This distribution is appropriate for driving in a straight line.

Because the drive torque is equal at the left and right wheels, any differing friction coefficients on the left and right are not initially factored in (of course, ASC+T will intervene if one or more wheels are threatening to spin as a result).

Longitudinal distribution of the drive torque by xDrive



Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel

Distribution of the Drive Torque (xDrive w/ DPC)

Dynamic Performance Control now also enables infinitely variable distribution of the drive torque between the wheels on the rear axle. Instead of a longitudinal distribution, as provided by xDrive, Dynamic Performance Control provides a lateral distribution of the drive torque. That is why, in technical documentation, the term "rear axle lateral torque distribution" often appears as a synonym for the sales designation "Dynamic Performance Control".

A new rear differential developed on the basis of a conventional differential allows the torque flow to and from the wheels to be controlled.

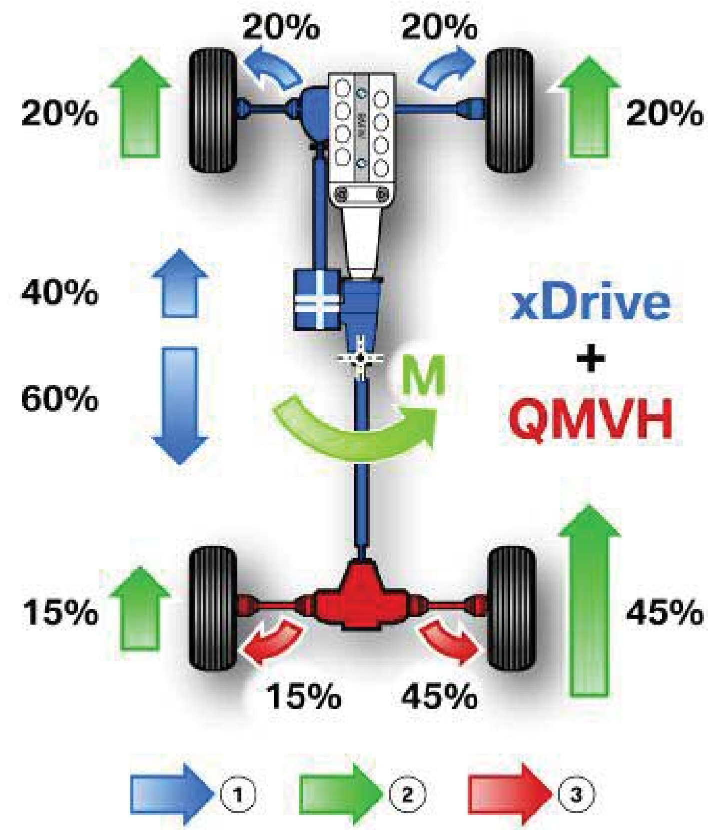
This means that not only can stability and traction be further increased, but the vehicle's agility can also be improved.

The combination of the xDrive and Dynamic Performance Control systems is able to further improve the vehicle behavior under acceleration and on surfaces with different friction coefficients on the left and right. Lets assume that the right rear wheel is on dry asphalt and the left rear wheel is on snow. In addition to the longitudinal distribution of the drive torque by xDrive, Dynamic Performance Control allows the drive torque to be distributed between the rear wheels. In this situation, the majority of the drive torque will be transmitted to the right rear wheel, because the left rear wheel can only generate relatively little driving force due to the low friction coefficient. This can avoid ASC+T having to intervene by applying the brakes.

The uneven distribution of the torque at the rear wheels has a second effect that is also used by Dynamic Performance Control.

Torque (M) is generated about the vertical axis of the vehicle. This means that the rotational motion of the vehicle about the vertical axis when cornering can be intentionally influenced. You can use this effect to turn the vehicle harder into a corner or to dampen the rotational movement.

Longitudinal distribution by xDrive, lateral distribution by Dynamic Performance Control (QMVH)



Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel
3	Drive torque distributed by Dynamic Performance Control
M	Torque about the vertical axis of the vehicle (= yaw moment)

Fixed Distribution of the Drive Torque with Conventional Rear Differential

A conventional rear differential consists of an angle drive and a differential gear and always distributes the drive torque equally (50:50) to both sides. Different rotational speeds are balanced out.

The different gear ratios for the various vehicle models are achieved by the different number of teeth on the drive pinion and crown gear.

Distribution of the Drive Torque by the Rear Differential with Mechanical Locks (limited-slip differential)

A open/conventional differential has two beneficial features:

- The speed of the drive wheels can differ from each other because of the different distances they cover when cornering.
- The drive torque is always distributed equally to both drive wheels and does not therefore generate any yawing.

These benefits are counterbalanced by a major disadvantage if the tire-road adhesion is different at the two wheels. The propelling forces that are to be transferred to the road are then limited to the lower of the two potential adhesion levels at the drive wheels.

If the adhesion ratio is unfavorable on one side, it means that a vehicle (without electronic dynamic driving system) would not be able to move off. The drive torque would be converted into useless rotational acceleration for the wheel with the lower potential adhesion level, while the higher potential adhesion of the second drive wheel remains unexploited.

Selectable and self-locking rear differentials are fitted in order to eliminate this disadvantage of the differential gear.

Variable Distribution of the Drive Torque in the Rear Differential with Superimposing Gear Units

The new rear differential with superimposing gear units abolishes this fixed torque distribution by the differential gear. The differential gear is supplemented by a superimposing gear unit on each side. These provide a second additional path along which the drive torque can be transmitted.

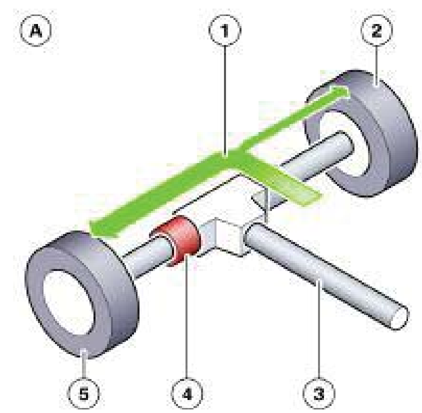
In all three load situations:

- traction,
- coasting and
- overrun

the BMW Dynamic Performance Control system allows the torque to be ideally distributed between the two rear wheels.

A - Torque Transfer Under Traction

The **traction** load situation means that the engine is generating a positive drive torque. In this respect, the functions of the BMW Dynamic Performance Control hardly differ from those of the competition. The BMW system can transfer up to 1,800 Nm of drive torque from one wheel to the other.



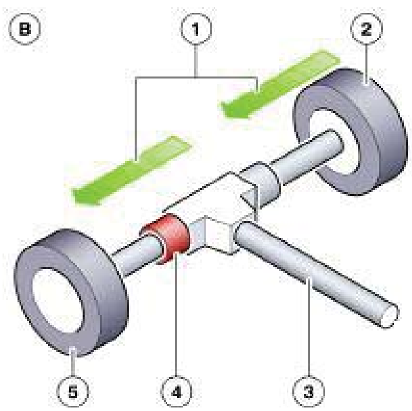
Index	Explanation
1	Lateral distribution of the torque
2	Left rear wheel
3	Propeller shaft
4	Activated superimposing gear unit
5	Right rear wheel

The competitive advantage of the BMW system becomes clear in other load situations.

B - Torque Transfer During Coasting

During **coasting**, there is no drive torque (0 Nm).
When there is power being transmitted between the engine and transmission, this occurs when the engine torque is exactly equal to the loss torques. It also occurs if the driver disconnects the power transmission between the engine and the gearbox (selector lever in the neutral position).

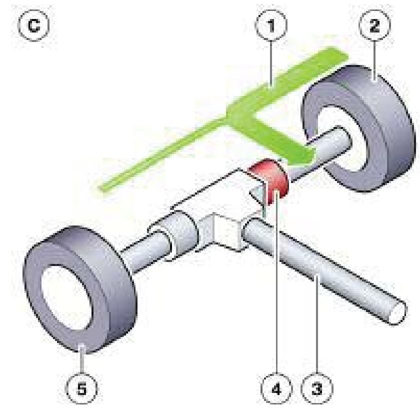
There is then zero torque at the input to the rear differential. In contrast to the competitors' systems, Dynamic Performance Control can also bring about torque transfer in this load situation. If a wheel is to receive positive torque, an equal amount of negative torque will occur at the other wheel.



Index	Explanation
1	Lateral distribution of the torque
2	Left rear wheel
3	Propeller shaft
4	Activated superimposing gear unit
5	Right rear wheel

C - Overrunning: Negative Torque in the Propeller Shaft

If the engine is delivering negative torque, e.g. during overrun fuel cut-off, this is known as overrunning. Even in this case, Dynamic Performance Control allows torque transfer, i.e. a negative torque can also be distributed asymmetrically to the two wheels. The torque transfer can even be increased to such an extent that there is an extremely large negative torque at one wheel and a slight positive torque at the other wheel.



Index	Explanation
1	Lateral distribution of the torque
2	Left rear wheel
3	Propeller shaft
4	Activated superimposing gear unit
5	Right rear wheel

Improved Traction

Accelerating Out of Corners

Dynamic Performance Control enables improved cornering traction by adapting the torque distribution to the potential adhesion between each tire and the road.

The vehicle can be accelerated out of the corner more quickly without impairing directional stability.

The rolling motion of the vehicle when cornering generates different wheel contact forces. The contact forces at the wheels on the outside of the corner are greater than those at the wheels on the inside of the corner.

Therefore, the maximum forces that can be transferred to the road are greater at the wheels on the outside of the corner than at the wheels on the inside of the corner. Dynamic Performance Control has an ingenious way of using this effect. If the driver accelerates while cornering, more drive torque is distributed to the rear wheel on the outside of the corner than to the rear wheel on the inside of the corner. In this way, the adhesion potential of the rear wheels is better exploited. Overall, the vehicle can make use of a greater drive torque to accelerate in the corner.

Driving off on Surfaces with Varying Friction Coefficients

The improved traction when pulling away will be particularly noticeable to the driver when the road surface has various friction coefficients. This mixture of friction coefficients makes the variable distribution of the drive torque between the individual wheels more evident.

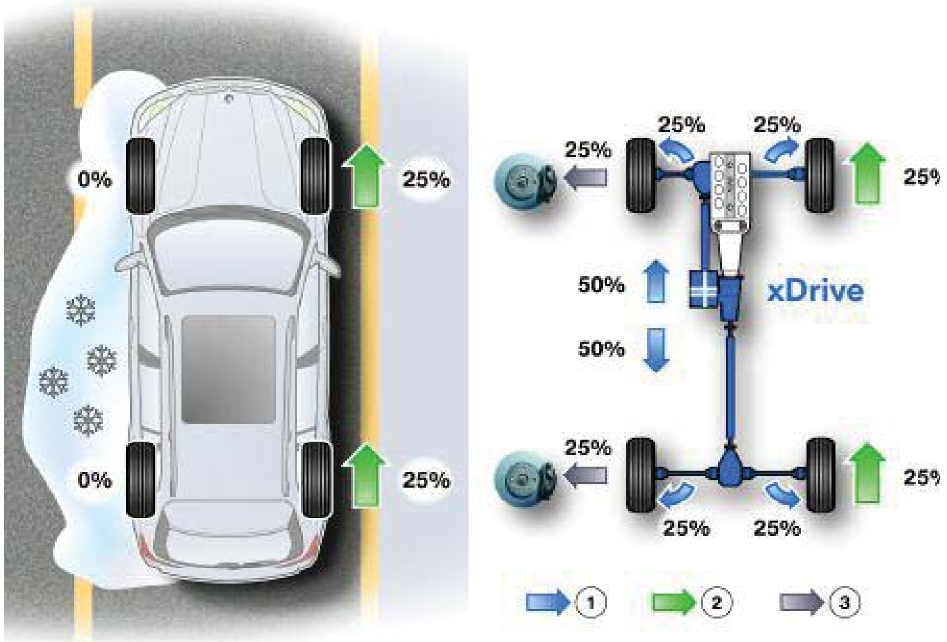
Dynamic Performance Control distributes the drive torque to the side where more power can be transferred.

Lets look at a situation where the vehicle is pulling away with different friction coefficients on the left and right sides to compare the basic principles for torque distribution in xDrive and Dynamic Performance Control.

- xDrive

In this situation, the xDrive system distributes the drive torque equally to the front and rear axles. The front and rear axle transmissions transfer the drive torque evenly to the left and right sides. The front and rear wheels on the left-hand side cannot, however, transfer any driving force to the icy road. ASC+T applies the brakes to the left wheels, converting their proportion of the drive torque into heat. The entire proportion of the drive torque transferred to the wheels on the right-hand side (25% each) is available for acceleration.

In effect, then, 50% of all the torque generated for pulling away is efficiently utilized.



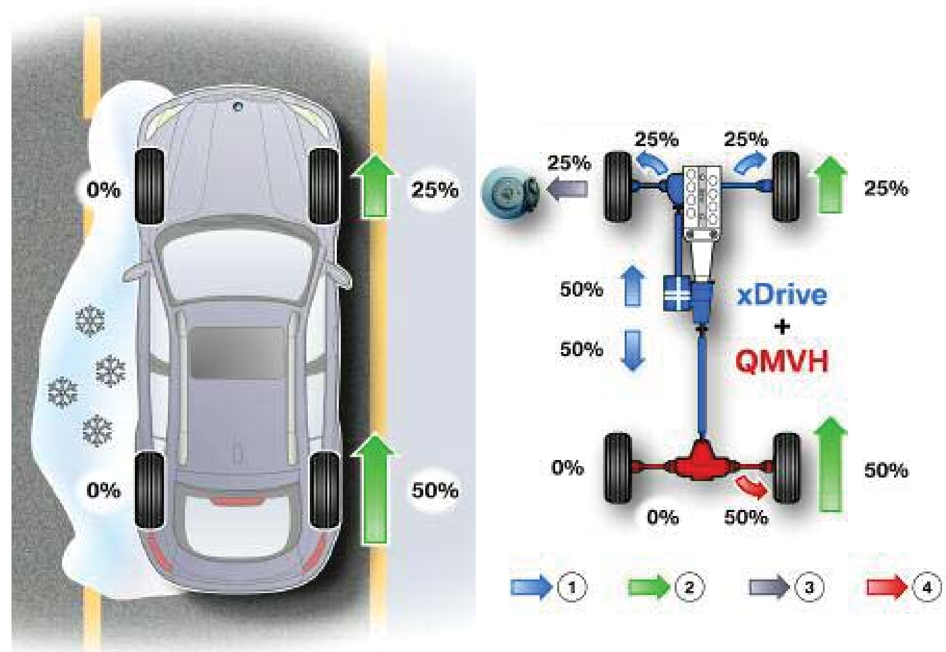
Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel
3	Driving force not available due to braking by ASC+T

- xDrive with DPC
The combination of the two systems, xDrive and Dynamic Performance Control, further improves the already good pulling away performance on surfaces with various friction coefficients. Dynamic Performance Control detects that the left rear wheel is threatening to spin using the wheel speed signals (in a similar way to ASC+T). Instead of ASC+T reducing the drive torque by applying the brakes, Dynamic Performance Control diverts virtually all of the drive torque at the rear axle to the right rear wheel.

Because a QMVH differential is only used on the rear axle, the torque distribution at the front wheels remains unaffected. ASC+T still needs to apply the brakes here to prevent the left front wheel from spinning.

There is now a total of 75% of the drive torque available for pulling away (50% at the right rear wheel, plus 25%at the right front wheel).

Particularly on surfaces with various friction coefficients, a vehicle with Dynamic Performance Control will have more tractive force at its disposal and will thus be able to accelerate harder than a vehicle that is only equipped with xDrive. By laterally distributing the drive torque, Dynamic Performance Control therefore improves traction when pulling away.



Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel
3	Driving force not available due to braking by ASC+T
4	Drive torque distributed by Dynamic Performance Control

Increased Agility

The intelligent interaction between the mechatronic systems, DSC and xDrive, guarantees excellent traction and stability.

However, there is a certain conflict of objectives, which generates more stability at the expense of agility.

Dynamic Performance Control, which is also a mechatronic system, is a logical enhancement to DSC and xDrive, because it can provide an infinitely variable distribution of the drive torque between the left and right wheels on the rear axle. This is pretty much regardless of how much input torque there is.

The conflict between stability and agility is therefore resolved for the first time.

Increased agility can be perceived in the following dynamic benefits:

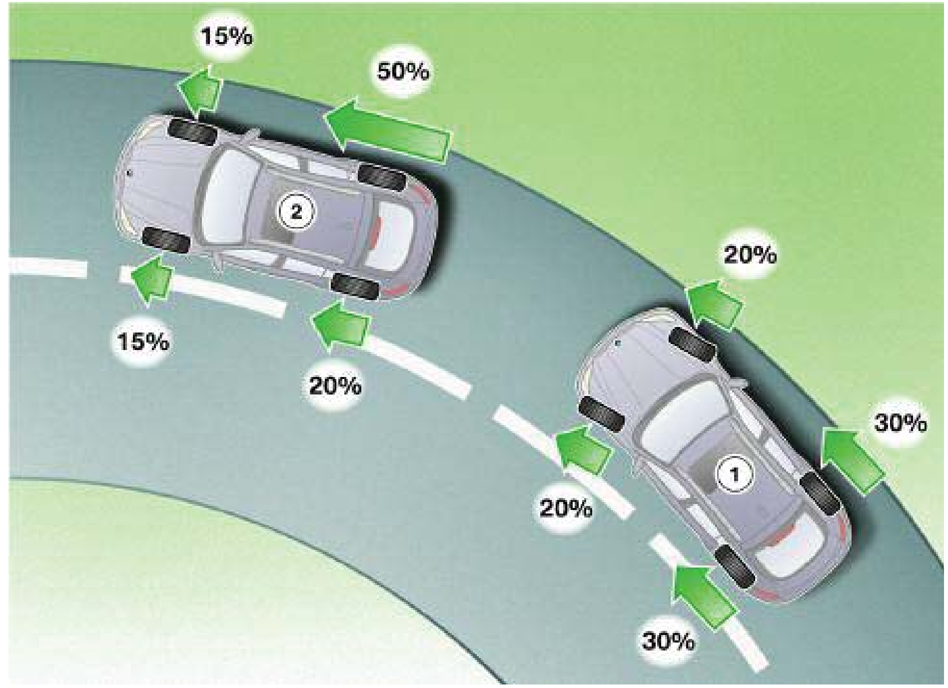
- Smaller steering angle requirement
- Less of a tendency to understeer

The vehicle responds more sensitively to steering input. With asymmetric drive torque distribution at the rear axle, Dynamic Performance Control effects an optimum yaw moment.

This controlled additional torque about the vertical axis of the vehicle makes it more "willing" to turn corners and reduces the amount of steering input required.

Less steering effort means greater steering comfort, reduced understeer and more precise steering through corners.

Increased agility in cases of understeer



Index	Explanation
1	Entering the corner, threatening to understeer
2	Torque distribution, understeer eliminated

Greater Directional Stability

As well as the considerably increased responsiveness of the vehicle with less steering input, any oversteer can also be noticeably controlled by the distribution of torque.

Dynamic Performance Control increases vehicle safety by appropriately damping the rotational motion of the vehicle about the vertical axis.

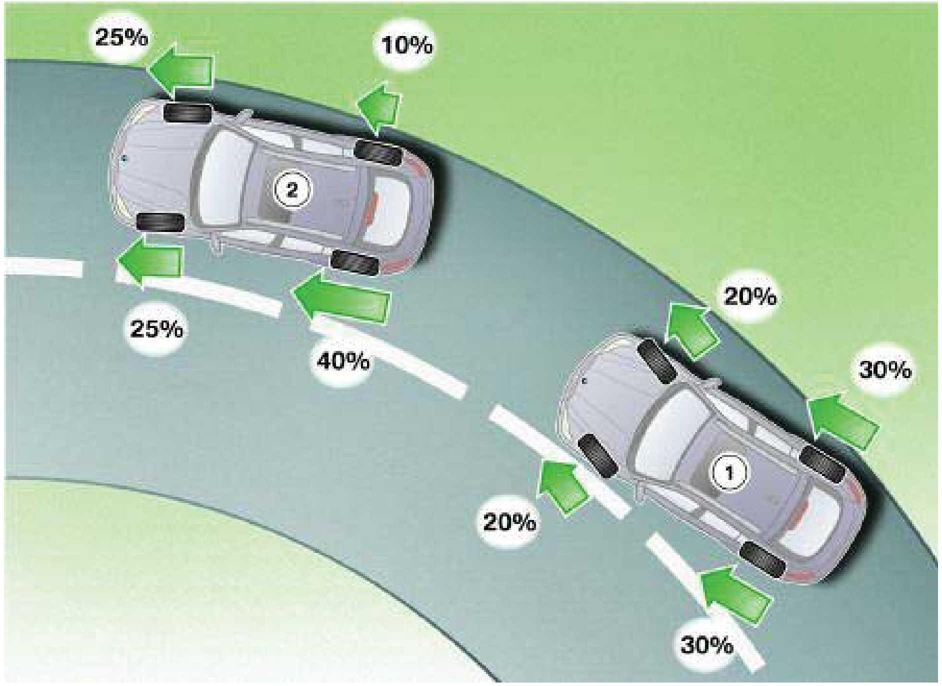
At the first sign of instability, e.g. oversteer, the drive torque at the rear axle is diverted to the wheel on the inside of the corner, thus preventing the rear of the vehicle from kicking out.

As soon as the vehicle is dynamically stable again, the torque distribution by xDrive also returns to the basic 40:60 distribution.

If the directional stability still remains close to the limit, DSC will of course also intervene. In this way, the various dynamic driving systems work together, coordinated by the Integrated Chassis Management, to achieve a common objective and to complement each other.

The result is, for example, more easily controlled vehicle behavior when you need to take evasive action.

Increase in directional stability for the example of oversteer



Index	Explanation
1	Entering the corner, threatening to oversteer
2	Torque distribution, oversteer eliminated

Operating Modes and Displays

Normal Mode

The Dynamic Performance Control functions cannot be switched on and off. The system is available once the engine is switched on.

Evidently, no torque is transferred in gear P, because the vehicle is stationary and no power is being transmitted to the wheels. However, in gears N and R, the system can affect torque transfer.

The driver will get a new functional display for Dynamic Performance Control, which can be called up as one of the on-board computer screens and make permanently visible in the instrument cluster. If the display for Dynamic Performance Control was active last time the vehicle was driven, it will automatically appear again the next time the vehicle is driven.

Due to legal requirements, the vehicle's odometer reading must always be displayed for a fixed time after the engine is started. For this reason, a small symbol for Dynamic Performance Control appears when the engine is started with the odometer reading underneath it. This small symbol is also displayed if the driver switches to the Dynamic Performance Control screen from another on-board computer screen.

After a few seconds, the symbol is switched to full size for better legibility. It shows the drive train and the vehicle wheels from above, as well as the current torque distribution by xDrive and Dynamic Performance Control.

The amount of torque at a wheel is shown by the number of narrow segments. Together, the segments form a bar, the length of which is a measurement of the amount of torque at the wheel. In this view, only positive values are possible. If the torque drops to a value of 0 Nm, the segments disappear completely from the wheel concerned. Negative values are also displayed like this and so cannot be clearly indicated.

A few typical examples of the display with the full-size symbol are shown below.

Dynamic Performance Control display with small symbol and odometer reading (displayed upon engine startup)

Dynamic Performance Control display with standard longitudinal distribution (front/rear) and even lateral distribution (left/right)

Dynamic Performance Control display with longitudinal distribution biased to the rear and even lateral distribution (left/right)

Dynamic Performance Control display with standard longitudinal distribution (front/rear) and lateral distribution biased to the right

Break-in Phase

There are no different or additional running-in instructions for the rear differential with superimposing gear units than those that already exist for the conventional rear differential. Nor is there any diminished or reduced functionality due to the new rear differential.

Wear Over the Service Life

Notable wear occurs to two system components of the rear differential: the multi-plate clutches and the transmission oil in the superimposing gear units (see also the System components section). There are mathematical models for these two components that either compensate for the wear or monitor for impermissibly high values.

Continuous wear to the multi-plate clutches is offset by appropriate control of the electric motors. Constant adaptation processes running in the background determine the position of the electric motors at which there is no torque transfer. The last detected "zero position" during a driving cycle is saved in the QMVH control unit and is available as the start value for the next driving cycle.

Wear to the multi-plate clutches can be compensated for throughout their entire service life. This is ensured by their design and the configuration of the electric motor adjustment range.

Frictional wear and loading due to high temperatures also age the transmission oil in the superimposing gear units. For this reason, a wear algorithm is calculated that takes account of the following variables:

- Age of the transmission oil in the superimposing gear units
- Number of times a superimposing gear unit has been actuated
- Temperature of the transmission oil in the superimposing gear units

If the vehicle is driven with a normal or even a dynamic driving style, the transmission oil can be used for the entire service life of the vehicle without requiring changing. The result of the wear algorithm remains in the permissible range.

Only if the vehicle is driven with an extremely sporty driving style might it become necessary to change the transmission oil during the vehicle's lifetime. The wear algorithm then generates a fault code memory entry. The diagnostic system uses this fault code memory entry to suggest a transmission oil change.

Please note that when we talk here about transmission oil and changing it, we are only referring to the two reservoirs of the superimposing gear units.

The oil in the differential is a service life supply, as before.

Driving Off with a Limited Steering Angle Signal

The steering angle sensor in the steering column switch cluster (SZL) is only able to measure the relative steering angle directly. Its measuring range is between -180° and +180°.

The absolute steering angle can be calculated from the relative steering angle by counting the steering-wheel turns. This information is lost if the SZL not supplied with voltage (e.g. if the battery is disconnected). When the vehicle is subsequently started, only the relative steering angle is available initially. The SZL uses the signals from the wheel-speed sensors to determine the information about the steering-wheel rotation when first pulling away.

The following situation can be particularly problematic for all-wheel drive vehicles. The SZL was disconnected from the voltage supply. The vehicle is started on a snow covered road, for example. The driver depresses the accelerator pedal forcefully to pull away causing all the wheels to spin and requiring ASC+T to brake them again.

In this situation, the SZL may not be able to immediately determine the information about the steering wheel rotation. It is not possible again until the slipping stops. In the meantime, the full functions of Dynamic Stability Control and Dynamic Performance Control are not available.

During this transition period, the driver is informed of the limited availability of the stability control systems by the DSC warning lamp and a Check Control message.

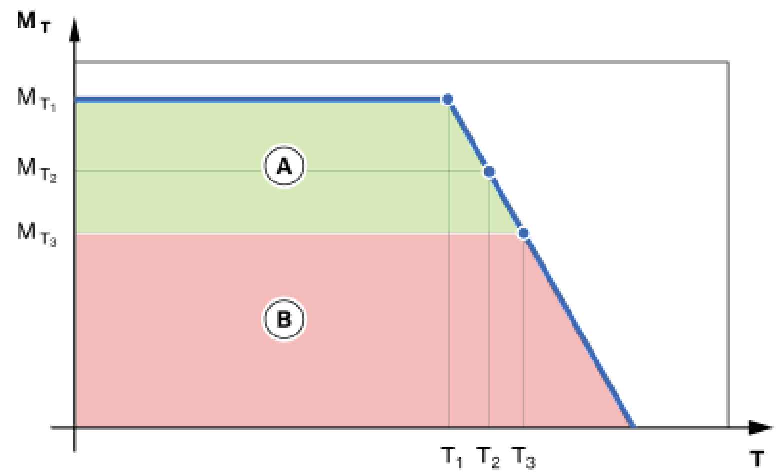
However, in this case, it is not a question of a fault, but a temporary unavailability of the systems. In the event of a complaint, the customer should be informed of this possibility.

Excessive Temperature

Excessive temperature can occur in the two electric motors or in the transmission oil in the superimposing gear units. Excessive temperature can cause damage to components or unduly high levels of wear.

The following measures are applied to prevent this.

Degradation of the torque transfer as a function of temperature



Index	Explanation
MT	Percentage performance of the required torque transfer by DPC
A	Normal operation without driver information
T	Temperature of the electric motors and/or the transmission oil in the QMVH
B	Restricted operation with driver information

Note: The system is able to detect a "sporty driving style". If it does so, the temperature threshold is temporarily increased by approximately 25°C.

The temperature of the electric motors and the transmission oil in the two superimposing gear units is measured. The signals from the temperature sensors are analyzed by the QMVH control unit.

In the first temperature range, the QMVH control unit makes available the full amount of torque transfer (M_{T1} = 100%). If the limit value T_1 is exceeded, the QMVH control unit reduces the torque transfer performance.

In the example shown, the transmission oil in one superimposing gear unit has temperature T_2. The torque transfer is then reduced to M_{T2} = 80%. If the Integrated Chassis Management requires a torque transfer of 1,000 Nm, only 800 Nm is provided by the QMVH control unit.

The reduced performance is reported back to the ICM control unit, so that it can be taken into consideration for the higher-level dynamic driving control. The reduced work of the superimposing gear units reduces the input of frictional heat, thereby preventing further heating.

The driver is not informed of the limited function of Dynamic Performance Control until the vehicle handling is markedly altered by the reduction in torque transfer. This threshold is marked as M_{T3} in the diagram. The relevant display - see below - is not activated until this point.

xDrive and/or DPC not available

System Not Available

If xDrive or Dynamic Performance Control (or both) is not available, the function display is dimmed. Because the customer does not then benefit from the large bar display, the display is also switched to the smaller symbol size.

The driver cannot determine whether xDrive or Dynamic Performance Control is causing the fault in the system using only the dimmed function display. The distinction can be made using the associated Check Control message.

A failure of Dynamic Performance Control has a similar effect to the failure of Dynamic Stability Control. Driving stability is limited.

Therefore, if there is a system fault in Dynamic Performance Control, the same Check Control symbol is used as for DSC. An instruction in the Central Information Display asks the driver to drive carefully. In addition to this Check Control message, the fixed warning lamp in the instrument cluster is constantly lit yellow.

Display in the event of a DPC system failure

The Check Control symbol for a fault in the xDrive system shows the customer that all-wheel drive is no longer available.

Check Control symbol for xDrive fault

Dynamic Performance Control in the ICM network

The ICM control unit's monitoring of the driving situation can be used for both systems (AL/AFS and DPC). The interpretation of the directional input at the steering wheel by the driver is also of use for the two systems. For the Dynamic Performance Control system, the engine torque requested by the driver and the torque provided at the transmission output are also analyzed. The ICM control unit therefore reads the relevant signals from the engine control system and the electronic transmission control system.

A particular feature in the ICM network is the xDrive system, which is used to help control the longitudinal distribution of the drive torque.

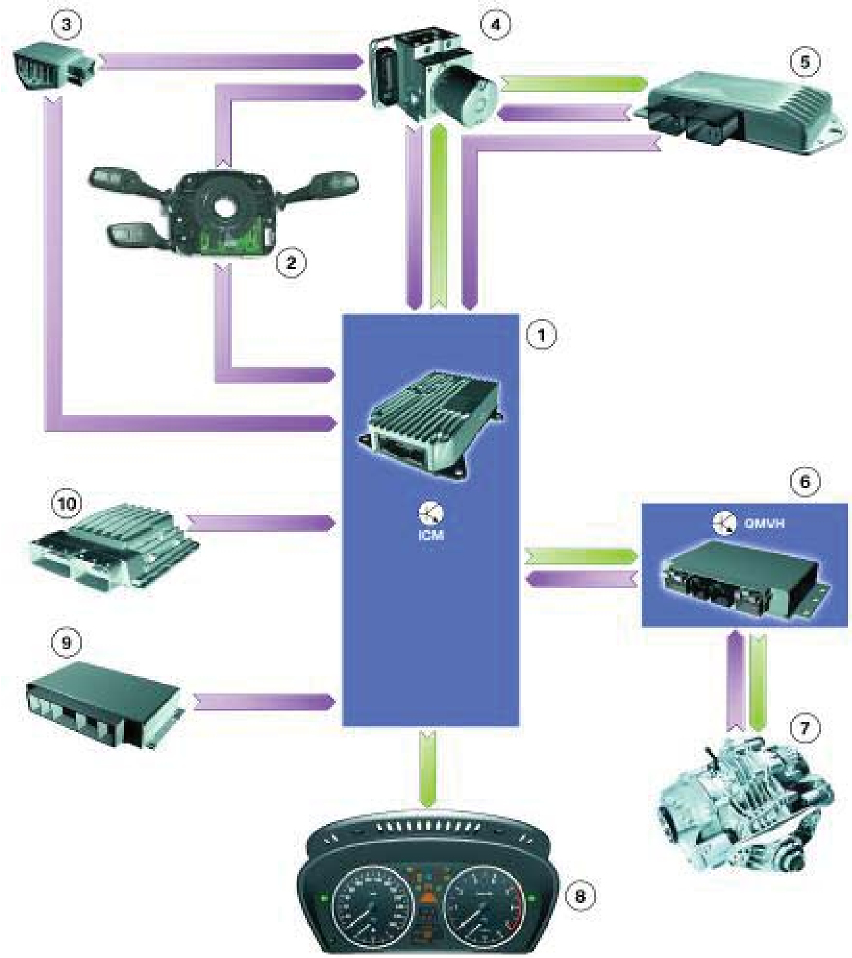
As in the all-wheel-drive vehicles already available on the market, the DSC control unit in the E71 continues to calculate the setpoint value for the distribution of the drive torque between the front and rear axles. The transfer case control unit applies this setpoint value and feeds back the actual value of the torque distribution. In the E71, it is no longer only the DSC control unit that receives this signal, but also the ICM control unit, so that the drive torque available at the rear axle can be determined.

Using the current driving situation, the driver's input and the drive torque available at the rear axle, the Integrated Chassis Management calculates a setpoint value for the QMVH control unit. This specifies how much drive torque should be transferred from which rear wheel to the other and is sent via the ICM-CAN.

The QMVH control unit has the task of implementing this setpoint value by energizing the actuating elements. In doing so, it must first detect which side, i.e. which of the two superimposing gear units, needs to be energized. This should occur on the side on which the greater drive torque should be applied.

The QMVH control unit in the E71 is purely an actuating control unit, in a similar way to the Active Steering control unit.

Dynamic Performance Control IPO



Index	Explanation	Index	Explanation
1	Integrated Chassis Management	6	Rear axle lateral torque distribution
2	SZL with steering angle sensor	7	QMVH rear differential
3	DSC sensor	8	Instrument cluster
4	Dynamic stability control	9	Electronic transmission control
5	Transfer box control module	10	Engine control system (DME)

In order to ensure that the setpoint value is applied, the QMVH control unit reads the signals from the motor position sensors. There is also motor position control for Dynamic Performance Control in the same way as for Active Steering.

The QMVH control unit uses the motor position to determine the drive torque that is actually transferred and transmits this information back to the ICM control unit.

The interface between the ICM control unit and the instrument cluster serves to activate the function displays and to indicate fault statuses. See the "Operating modes and displays" section.

Service Information

Running-in Phase

There are no different or additional running-in instructions for the rear differential with superimposing gear units than those that already exist for the conventional rear differential.

Driving Off with a Limited Steering Angle Signal

If the steering column switch cluster (SZL) has been disconnected from the voltage supply, only the relative steering angle can initially be measured. The SZL does not calculate the absolute steering angle using the wheel speed signals for calibration until the vehicle has been driven for a few meters.

Until this point, only limited functions of the Dynamic Stability Control and Dynamic Performance Control dynamic driving systems are available. The driver will not normally notice this phase.

A Check Control message is only issued if the driver pulls away sharply on a surface with low friction immediately after the engine has been started. However, there is not a technical fault. Once the steering angle sensor has been calibrated with the wheel speeds, all functions of the dynamic driving systems are automatically available again.

Excessive Temperature

Excessive temperature can occur in the electric motors or in the transmission oil in the superimposing gear units. This can cause damage to components or unduly high levels of wear. To prevent this, the requested torque transfer is only implemented to a reduced extent if excessive temperature is detected.

This reduction happens without the driver noticing. A Check Control message is not issued until the vehicle's behavior is noticeably altered by the reduction. A careful driving style will automatically result in the components being cooled, so that the full functionality is soon available again.

The system is able to detect a "sporty driving style". If it does so, the temperature threshold is temporarily increased by approximately 25°C.

QMVH Unit

The angle when the rear differential with superimposing gear units is removed and refitted must be no more than 45° due to risk of the oils mixing together through the common vent.

Electric Motors

The following must be observed when one or both of the electric motors are being replaced:

- When an electric motor is removed, small quantities of oil may escape. This volume of oil is so small in relation to the overall volume that it is not necessary to top up the transmission oil.
- Only the correct left/right motor may be used for the replacement. Identify the electric motor correctly using the Electronic Parts Catalogue.
- Following the replacement of one or two new electric motors, a set-up process must be started using the diagnostic system. This will transfer data from the motor position sensor to the QMVH control unit.

Control Unit
The QMVH control unit continuously calculates wear data for the transmission oil and multi-plate clutches during normal operation. The control unit also reconciles the control unit data with the fitted electric motors.

A digital interface with the motor position sensors is used for this purpose. This results in the following particularities if the QMVH control unit needs to be replaced during the course of a repair.

Before The QMVH control unit is removed, all data regarding the status of the rear differential with superimposing gear units must be read out, if possible, using the diagnostic system.

Once the new QMVH control unit has been fitted, programmed and coded, the diagnostic system must be used to work through a set-up procedure.

During this, the data that was previously read out regarding the status of the rear differential with superimposing gear units will be written to the new control unit. The control unit will also be set to a mode which restarts all adaptation processes, so that perfect interaction between the control unit and the superimposing gear units can be established as soon as possible.

ICM Control Unit

When the ICM control unit is coded, the vehicle identification number is written to the control unit. This means that a simple exchange between two vehicles does not provide a solution to a fault. Following the programming or replacement of an ICM control unit, coding must therefore be carried out. This is part of the set-up process conducted by the diagnostic system.

During normal driving, the ICM control unit carries out calibration processes on the sensor signals. The offset of the steering wheel angle is determined in this way, for example. Values of this type are required for the higher-level dynamic driving regulation. Following the programming or replacement of an ICM control unit, these calibration processes must be explicitly initiated. The diagnostic system has a corresponding Service function.

The actual calibration process does not take place until the next trip. The sensor signals cannot be calibrated to each other until the dynamic situations actually occur. This process takes place in the background, so that the customer will not realize it is happening.

As you were already able to see from the bus overview and the distributed functionality, the ICM control unit is not an independent control unit. Instead, it is in a close network with the QMVH and AL control units and, of course, the DSC. All these control units use similar or identical sensor signals (e.g. wheel speeds, yaw rate, steering wheel angle). Take this background information into consideration when performing diagnostics on the dynamic driving systems, for example, do not only check the fault memories of the individual control units, but the fault memories of all the control units in the network.

Workshop Exercise - Service Functions for Dynamic Performance Control

Using an instructor designated vehicle, run a short test on an E71 and complete the following questions.

Diagnostic Software Version

In the Service Functions section of the Function Selection; Under which major heading does the QMVH system appear?
Circle the correct major group below.

Maintenance

Drive

Chassis

Body

Vehicle Information

Does the sub group appear as QMVH? If not what is the sub group for QMVH called in the diagnostic software?

What test plans are available under for the QMVH system?
Write them in the spaces provided below.

Run the test plan for oil replacement.

How does a technician know that the oil for the QMVH system must be replaced?

Run the test plan for Startup QMVH.

What are the two options given?

[1]

[2]

What options are given under option [2]?